PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited,
167-176 TIMES BUILDING, NEW YORK.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 28 Hathaway Building, Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION, IN ADVANCE, ONE YEAR $3.
(Including Postage in the U. S., Canada or Mexico.)

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VOL. XIX. NEW YORK, MAY 14, 1892. NO. 20.

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Heating of Armatures. In another column we publish a very instructive paper of Mr. Rechniewski on a subject which has heretofore not received the attention in current literature that its importance would seem to warrant. A dynamo is different from a steam or gas engine in so far that the latter have a nearly fixed limit in their capacity, while that of the dynamo is limited only by the heating, provided the mechanical parts are strong enough. A dynamo can therefore be forced, often far beyond its normal capacity. The efficiency, of course, will suffer thereby, but its reduction does not necessarily limit the output definitely. He advances the important proposition made some time ago by others, but apparently never worked out in such detail, that the heating is really limited by the number of watts converted into heat in the armature and the area of cooling surface of that armature. The guide that many dynamo builders have taken is that a certain sized wire will carry a certain current; in other words, in designing a dynamo a certain number of circular mils of cross-section per ampère can be assumed. This, however, is evidently not rational, for suppose two cases, in which the same size of wire and the same current are used, but in one of which there are four layers deep on the armature and in the other two, the diameter of the armature being in that case twice as great. The number of watts converted into heat will be roughly the same in both while the cooling surface will be twice as great in the second case, in which therefore the heating will naturally be less. He proceeds to give figures obtained from actual machines in which he finds the constants sought for, namely, the area of cooling surface per watt lost in the armature, to vary from about one-half to one and one-quarter square inches for normal ventilation. This figure should be the guide in designing armatures and not the circular mils per ampère, which is evidently irrational. But, as in many other similar cases, this figure should be used as a guide or check, and not as a basis for beginning the calculations of an armature.

New Edison Telephone Patents. AT last the much-talked-of Edison patents for the carbon transmitter have been issued, and as they may affect the monopoly of the Bell Telephone Company for the telephone, they are of great interest to the public. It has long been known that the applications for these patents existed in the office, being kept there under the pretense of repeated interferences, and that the Bell Telephone Company owned all the applications which were in interference, and that by conducting a sort of sham battle in the office between themselves it kept the applications there for 15 years. The object is evident; if the patents are really valid it would give the Bell company practically a monopoly of the telephone for an additional 17 years, as the fundamental Bell patent expires next year. They have now been issued, whether at the request of the owners or in accordance with the demands of the Patent Office officials is not known. At all events the sham battle is over, and as these patents, in accordance with the United States laws, are dead, the whole fight recalls that of the Kilkenny cats. In another column we publish a description of these patents together with some opinions obtained from leading authorities. From the latter, however, it will be seen that there is a great difference of opinion in the matter. Whether they cover the carbon transmitter broadly enough to control it is a question, but let us assume, for the sake of argument, that with the Berliner patent they do. The case may then be summed up as follows: According to our laws a United States patent expires with the date of expiration of the shortest termed foreign patent. Everybody knows this law when he makes application. Edison has, according to the requirements of the office, stated under oath that this invention was the same as that patented by him abroad. There can therefore be no question raised about its being a different patent; that "trick of the trade," which is sometimes made use of to evade this law, cannot be made use of in this case. There can be no question that according to the meaning of the law the term of the monopoly of this invention expired some time ago. But the question arises how the "letter of the law" can be applied in case the United States patent is not issued until after this term has expired. This appears to be the first case of the kind on record. The intention of this law is to relieve Americans from paying the patent royalty on articles made abroad where no royalty is required, thereby protecting our industries from too great a competition from abroad. The Bell company may put in the plea that it has, through no fault of its own, been deprived of the patent protection for this patent for 15 years, and that it ought, therefore, to be allowed protection for 17 years from date. This plea, however, would be a mere farce, for in the first place these people kept it there themselves, and it was, therefore, a trick, if not a fault, of their own; in the second place, they have had protection from the very beginning, as no one has had the right to use this. Every citizen who pays for the use of a telephone has paid them a royalty for this invention; they have made too much money from it already, more than they have a right to, as this patent really expired some time ago. But even admitting that the law could be twisted so as not to make the patents invalid, there still remain other unexpired foreign patents for this which will expire shortly, and which, according to the law, will make the United States patents expire very soon. No amount of argument can change this, unless the law be changed completely. The latter is a possibility, Edison having already expressed himself as dissatisfied with this law, which has affected him unfavorably before, and wishing to have it changed. This attempt has been made before, but the Supreme Court has decided in favor of the law in all the cases. There is no telling, however, whether this wealthy and powerful company, which has accomplished so much in the courts already, might not prove to be more powerful than the courts or Congress, and gain its point by some means. Congress may be appealed to, and if it wishes it can do what it pleases, or what pleases the company, but it is very questionable whether the company would succeed in this way; it would be an expensive proceeding. But it has been so successful in the courts that it may feel encouraged to try anything without regard to principles, law, or equity. We have been suffering for years with a very unsatisfactory telephone system operated purely for money without any regard for the kind of service. In other civilized countries the government has stepped in, here it has not, and it is a question now what the government will do when it gets a chance to relieve the public of a most objectionable monopoly. Some authorities appear to think there is no question of these patents being sustained, others the contrary. In any case there is no question about the equity in the matter, and as to the law, it depends on the ability of lawyers on the one hand and the ability of the courts or Congress on the other. The fight will doubtless be a hot and long one.

The Electric Current and the Human Body. A RECENT discussion in an engineering society on the dangers of the trolley brings up again the subject of what currents are dangerous. Notwithstanding the amount of matter published regarding the resistance of the human body and the current which will kill, the subject seems still to be greatly misunderstood by many, partly because numerous persons interested are not sufficiently well posted in electrical matters to understand the statements made, and partly because such statements often appear contradictory, making the whole subject look mysterious. There are, for instance, about as many different figures given for the resistance of the human body as there are authorities for such statements. Furthermore, the question is often asked, "How many volts will kill?" It is stated by some that 30 or 40 volts will kill a horse, while others ask why it is that Tesla is not killed when he takes many thousand volts if 3,000 volts has been known to kill in a number of cases. The writer himself, on the top of one of the Alpine peaks in a storm, has had lightning pass through his body to an extent sufficient to make a loud crackling noise and to produce long blue streams of sparks from the fingers, representing probably many millions of volts, without any effect on the body other than to induce him to descend without delay. Others report having taken "the full current of a 1,000 volt alternating current machine through their body" without fatal effects, while in still other cases flesh has been burned to the bone without proving fatal. These apparently contradictory statements make it seem to many that little is known about this subject. This is not the case, however. Although there is room for more definite knowledge, a good deal is known; it requires only to be properly stated. It reminds one of the old story of the color of the chameleon; all three of the observers were right in their observations but wrong in their conclusions. Regarding the resistance of the body it is well known that this resides chiefly in the skin. If the skin is very dry and thick, as on some workmen's hands, it is almost an insulator; while if it is moistened with perspiration, with water, or better yet with caustic potash, which penetrates the pores as it dissolves the fatty substances, the resistance of the skin becomes very low. The condition of the skin and the size of the electrode in contact with it are therefore probably the most important factors in measuring the resistance of the body. If the electrodes were placed in incisions made through the skin the resistance would doubtless be exceedingly low. A horse is easily shocked through the shoes because the nails penetrate into the moist parts of the hoof, thus making a good contact through the insulating horny substance; besides this, his hoofs are often wet with mud. The current necessary to kill depends very much on the nature of the contact with the moist parts of the body and it therefore cannot be said that a certain number of volts will or will not kill. Furthermore, the quantity of the current in ampères actually trasversing the body is also an important factor. In Tesla's machine the quantity of current is small and insufficient, as the body is capable of taking care of it rapidly enough to prevent danger. The source of the current must therefore be great enough to develop a sufficient quantity of current as distinguished from the voltage alone. In all electric light and power circuits there is always sufficient quantity. It would appear from this that the number of ampères might be a better gauge than the number of volts, but the time is also of importance, as the same current is no doubt more dangerous if it continues to pass for a longer time. One author states that one-tenth of an ampère for one second is sufficient to kill. This, though more rational than merely the number of volts, is still not sufficiently definite, as in many cases a great enough number of ampères has been taken locally to burn and char the flesh without producing death. It appears, therefore, as Prof. Houston pointed out, that a current, to cause death, must pass *across* the body; that is, through some vital part, and not merely through part of an arm or a leg. A comparatively large current passing in at the hand and out the shoulder would not necessarily cause death directly, but if it passes through to the other hand, thereby passing through the heart, it would doubtless prove fatal. To summarize, it is therefore not rational to speak in general of the definite resistance *per se* of the human body, nor to say that more than a definite number of volts is fatal, except between very wide limits. The nature of the contacts must first be considered, then the number of ampères, and the duration, and finally the question of the current through the body in relation to the vital parts. The voltage must then be great enough to send that current through that particular resistance of the body, according to Ohm's law, and the source must generate a sufficient quantity of electricity to keep this current flowing. Finally, there appears to be also a counter electromotive force in the body, which must be considered, and there is besides doubtless a difference between the effects of alternating and direct currents. A direct current probably decomposes the tissues by electrolysis and a high potential discharge may act in the form of rupture of the tissues.

Ohm's Law.

BY ARTHUR G. WEBSTER.

I desire to make a few comments on the remarks on Ohm's law in the last edition of THE ELECTRICAL WORLD and the editorial thereon. There is a tendency, not unknown to scientific men, to account for phenomena which one does not understand by a reference to the probable existence of some new phenomenon. It is a relief, after so much nonsense has been talked about Ohm's law, to get a collection of opinions which agree in the main so well. The fact that some disagree is not such as to "make the judicious grieve." In the town in which I live a lecture was recently delivered by an eminent professor of theology, who made the statement, when referring to the alleged disagreements of theologians, that scientific men differed among themselves more than theologians had ever begun to differ. This, I suppose, shows how much we know about scientific men. But I venture to express the hope, as you have done in your editorial, that a seeming disagreement here will not make the unskillful laugh.

By those who are disposed to doubt the truth of Ohm's law for variable or alternating currents I would propose consideration of the following question: Does any one doubt that in any current phenomena, if the specific resistance of all the conductors be increased in a certain ratio, and all electromotive forces remain the same, that all the currents will be decreased in the same ratio? This may be considered a hasty statement. Some one may say, how can the induced electromotive forces remain the same if the currents be changed? Perhaps a better supposition is, let the linear dimensions of the system be increased in the same ratio as the resistances, then the currents are diminished in the same ratio. If not, what becomes of our so-called determinations of the ohm, most of which have been determinations of the specific resistance of mercury, and many made by means of alternating (or variable) currents?

With regard to high frequencies, I may remark that all inductive actions depend on the time-rate of change of the inducing currents, which is the reason that the inductive effects are proportional to the frequencies. $\frac{d}{dt}(2\pi n t)$ contains the factor n, the frequency, hence the reason of the great inductive power displayed in Mr. Tesla's experiments.

With regard to the newness of Tesla's experiments, I must plead guilty to not being in sympathy with your remarks on "the inevitable European anticipator." As to the facts developed by Tesla, I venture the opinion that there is nothing that is not contained in Maxwell's Vol. II., published twenty years ago. To be sure, Maxwell never produced any currents of high frequency (intentionally)—he was doing something else. But Hertz did—because he was one of the Germans who had read and thought over his Maxwell. And so did Lodge. Why did Hertz stir up such a breeze? Was it on account of his papers, which showed such a deep-reaching acquaintance with the theory, or was it because of his striking experiments, which any one could repeat. Lodge's work has not received the attention it deserves, but if Hertz had suddenly died, Lodge would probably have reached the same results, and perhaps made just as great a stir.

Some of Tesla's most striking experiments depend on the illumination of tubes or lamps without electrodes, or with but one. An experiment was performed several years ago by a gentleman in Vienna (I think Dr. Moser) with a double Geissler tube without electrodes. One tube surrounded the other, which was exhausted. On bringing the tube near an induction coil, and beginning to exhaust the outer tube, the latter glowed, while the inner remained dark, being screened from action by the conducting gas in the outer tube. On highly exhausting the outer tube, its conductivity diminished, and the inner tube began to glow, while finally the outer ceased. To my mind this experiment is as instructive as any of Tesla's. There is nothing, of course, in this to detract from the great interest and beauty of Tesla's experiments, but I am inclined to agree with Mr. Wimshurst that the principal difference between these and others is in the expenditure of energy involved. The experiments of Tesla and Thompson have often led me to suspect that many physicists would feel like saying that it is not so hard to make lightning if you have a big factory behind you.

Another remark of Mr. Wimshurst reminds me that some people like to make a great distinction between electrostatic and electromagnetic effects of alternating currents or waves. Now, what is the use of this distinction? Is not every electrostatic disturbance in space accompanied by an electromagnetic one? And can an electrostatic effect be propagated at all except by means of an electromagnetic wave? If so, I do not know how, and the two seem to me to go hand in hand.

By the way, many persons have the opinion that the period of oscillations in an electric system is inversely proportional to the square root of the product of its self-induction and capacity. The opinion is a very good one, if you know just what you mean by self-induction and capacity. But suppose you disturb a charge of electricity on a conducting sphere, and let it oscillate till it comes to rest: what is the self-induction of that circuit? (What circuit, too?) *Cela dépend.* It all depends upon how the currents distribute themselves over the sphere, and that of course depends on the self-induction of the circuit. So we cannot find one without the other. It turns out to be a question of differential equations, and I do not advise anybody to do it in his head, even if he has built lots of alternators.

To return to Ohm's law—it seems to me that among the answers given those best put are by Dr. Fleming, Mr. Swinburne and Prof. Silvanus Thompson. With the latter's answer No. 2 I thoroughly sympathize, even to his reference to the fourth edition of his "Dynamo-Electric Machinery," although it should have referred to the whole of the second volume of Maxwell. Especially to be commended is Prof. Thompson's last statement: "Remember that at high frequencies every inch of straight wire will act as a choking coil," *et seq.* To the doubter above mentioned I should recommend to "cut this out, and paste in your hat."

I hope you will pardon the liberty I have taken of rushing in where angels fear to tread, especially to add to what has been put forth by so many well-known names. My excuse must be that even a well-known name does not always prevent one from putting his foot in it.

I notice the absence from the list of one great American name—but then he doesn't believe in alternating currents anyway, and he has stated under oath that he didn't invent Ohm's law. But if you want to find out the truth about this matter, get up a patent case, and you will learn all about it.

Dynamo and Motor Calculation.

BY J. C. LINCOLN.

In THE ELECTRICAL WORLD of April 30 there is a very interesting and instructive article by Mr. C. H. Bedell. There is one statement in the latter part of the article, however, which seems to me to be open to question. He states that "In case of multipolar machines having the E. M. Fs. generated under like poles in series, the E. M. F. either of formula or chart should be increased in proportion to the number of such poles."

This seems to me equivalent to saying that it is possible to so connect up a multipolar machine that it will produce a higher E. M. F. than can be produced in the wire of the armature between any two adjoining pole pieces. This

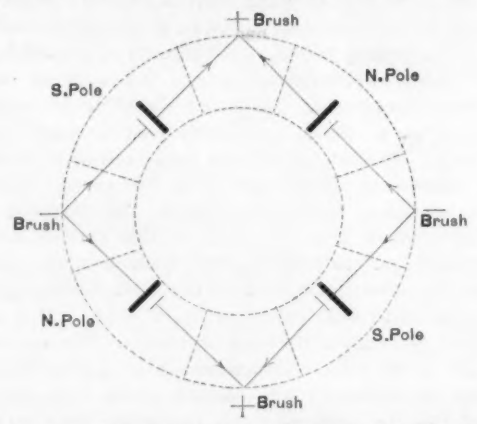


DIAGRAM OF CONNECTIONS OF MULTIPOLAR MACHINE.

cannot be, for the reason that in order to increase the E. M. F. of the machine it would be necessary to connect together the positive and negative poles. In connecting up batteries, for instance, if one wishes to get E. M. F. of both batteries he connects the positive of one to the negative of the other, and uses the remaining positive and negative as the terminals for his battery, and thus has twice the E. M. F. of one cell

But it is not possible to connect any positive and negative brush on a multipolar machine, for this will short circuit that portion of the armature which is included between the two brushes so joined, and burn out the machine. Mr. Bedell states that in case the brushes are connected with like poles and series, the desired result may be obtained. A little reflection will show that this cannot be true. The two negative brushes are at the same potential; joining them together will not alter the potential of either brush. The two positive brushes are at the same potential, and no connections can be made between the sets of brushes which will get a higher total E. M. F. than that produced between any one pair of brushes. In the case of the four pole machine the production of E. M. F. can be represented by the inclosed sketch, which shows batteries connected so that their E. M. Fs. act in the same way as the wire in a multipolar machine. The increase in the capacity of the machine is due to the fact that when two or more brushes are connected in parallel it really amounts to having two or more machines so connected.

The First Central Station Operated with Three-Phase Currents.

The Oerlikon company, of Zurich, Switzerland, has sent us the following additional facts regarding the plant at Heilbronn:

"In your article in No. 15, Vol. XIX., entitled: 'The First Central Station Operating with the Three-Phase Current,' we should like to point out that the three-phase current is not, as there described, used simply for a transmission of power to a central station in Heilbronn itself to be used there to drive a single motor which is a duplicate of the generator. On the contrary, the suitability of the three-phase system, not only for transmission but also for distribution of power in combination with lighting, is fully demonstrated at Heilbronn, the current being used for running both three-phase motors and lamps in parallel.

"The generating station at Lauffen is 10 km. (6 miles) from the town, and contains two three-phase generators of 300-h. p. each, giving a tension of 86 volts between any two of their three terminals. Of these two machines, one is at present used only as a reserve. The low tension current is transformed up to about 5,000 volts and is carried by three overhead wires of 6 mm. each (0.236 in.) to Heilbronn. Before entering the town the tension is reduced by stepdown transformers to 1,500 volts and is then carried by cables to a point of distribution in the centre of the town, whence it is led in various directions to the tertiary transformers, 23 in number, which are connected by feeders to a low tension network of 100 volts. Motors of a total power of 25 h. p. have already been installed, of which more than half have been in use a considerable time and have given perfect satisfaction. For lighting the station supplies about 1,400 to 1,500 incandescent lamps of various candle power, also 14 arc lamps of 8 to 10 ampères, leaving a large reserve capacity to accommodate the demand for both light and power, which is constantly growing among the inhabitants of Heilbronn."

It is thus seen that the three-phase current is actually used for the direct supply of lamps and motors, showing its suitability for combined transmission and distribution.

General Meeting of the American Institute of Electrical Engineers.

As was announced in our columns two weeks ago, the annual meeting of the American Institute of Electrical Engineers will be held in this city on the 17th inst. This meeting is for the members and invited guests only, and will be followed by a dinner at "The Arena," at 41 West Thirty-first street, the price of which has been fixed at $2 per plate. This will be a purely social gathering and the members hope that all who can do so will be present. The session of the annual meeting it is expected will occupy about two hours and will be given up to the reading of the annual reports, the election of officers and any other business of a similar character that may be brought before the members.

The general meeting of the Institute will be held at the Grand Pacific Hotel in Chicago on Monday, Tuesday and Wednesday, June 6, 7 and 8. All sessions of the general meeting will be open to the public, and a general invitation is extended to all who are interested in electrical progress to attend these meetings, which on account of the variety and number of the topics to be considered has been extended to cover the dates above given. Those who are not at present members of the Institute but who wish to attend are requested to send in their names to the secretary, Mr. R. W. Pope, 12 West Thirty-first street, New York City, so that they may receive copies of the official programme and secure the privilege of reduced rates of transportation, in case the arrangements now in progress are perfected. It is thought that the rate of transportation will be a fare and a third for the round trip. This rate can be secured if the attendance is sufficiently large to comply with the rules of the Central Traffic Association. An announcement will be made later whether such arrangements can be made.

A large number of papers are in preparation for the general meetings, and others are promised, which will be announced in the regular programme which will be issued at a later date. The preliminary programme is as follows:

1. Electric Coal Mining Machinery, by Elmer A. Sperry, of Chicago.
2. On the Electromagnetic Field, by M. I. Pupin, Ph. D., of Columbia College, New York City.
3. Long Distance Transmission for Lighting and Power, by Charles F. Scott, of Pittsburg, Pa.
4. A New Rheostat, by C. E. Carpenter, of Minneapolis, Minn.
5. A Dynamo Indicator, or Instantaneous Curve Writing Voltmeter, by Prof. George S. Moler, of Cornell University, Ithaca, N. Y.
6. Electrotechnical Education, by Prof. R. B. Owens, of the University of Nebraska, Lincoln, Neb.
7. The Magnetic Properties of Sheet Iron, by Milton E. Thompson, of Cornell University, Ithaca, N. Y.
8. Selective or Individual Signals, by Thomas D. Lockwood, of Boston, Mass.
9. Railroad Train Lighting, by A. H. Bauer, of Chicago.
10. A Discussion of Circuits Containing Resistance, Self-Induction and Capacity, by Messrs. Frederick Bedell and Albert C. Crehore, of Cornell University, Ithaca, N. Y.
11. A Life and Efficiency Test of Incandescent Lamps, by Prof. B. F. Thomas and Messrs. P. Martin and R. H. Hassler, of the Ohio State University, Columbus, O.
12. Notes on Wiping Contact Methods for Current and Potential Measurement, by Prof. B. F. Thomas, of Columbus, O.
13. Series Electric Traction, by Nelson W. Perry, of New York City.
14. Oil vs. Air as Insulation, by Dr. J. B. Williams, of New York City.
15. On the Electrolytic Refining of Copper, by Lieut. F. B. Badt, of Chicago.
16. The Photography of Alternating Current Curves, by Dr. Edward L. Nichols, of Cornell University, Ithaca, N. Y.
17. The Reversal of Polarity in Plating Dynamos, by Prof. H. J. Ryan, of Cornell University, Ithaca, N. Y.
18. Dynamos for Continuous Current Circuits, by Prof. Harris J. Ryan, of Cornell University, Ithaca, N. Y.
19. The Technical Education of the Electrical Engineer, by Prof. D. C. Jackson, of the University of Wisconsin, Madison, Wis.

Papers are also expected from H. Ward Leonard, Prof. Elihu Thomson and Prof. Geo. D. Shepardson, the subjects of which cannot be announced at present.

Organization of the General Electric Company.

The General Electric Company is a name already familiar to most of our readers as the official title of the new company formed by the consolidation of the Thomson-Houston Electric Company and the Edison General Electric Company. This new company will succeed to the entire business of both the Edison and Thomson-Houston companies. The officers of the new organization were chosen last week and are as follows: C. A. Coffin, president; Eugene Griffin, vice-president and general manager; S. Insull, second vice-president; A. S. Beves, treasurer; B. F. Peach, Jr., first assistant treasurer; W. F. Pope, second assistant treasurer; E. I. Garfield, secretary; A. S. Beves, assistant secretary; J. P. Ord, comptroller; E. Clarke, auditor. Directors: H. McK. Twombly, chairman; F. L. Ames, C. A. Coffin, T. Jefferson Coolidge, C. H. Coster, T. A. Edison, Eugene Griffin, F. S. Hastings, H. L. Higginson, D. O. Mills and J. Pierpont Morgan.

EUGENE GRIFFIN.

Thus it will be seen that the new company starts out with as strong and influential a set of officials as any financial organization could wish. The men who compose the board of directors are already familiar with the requirements of the electrical business and with the conduct of affairs of this nature. Most of them are men who have been connected with one or the other of the old companies for longer or shorter periods.

The history of these two organizations which are now finally merged into a single corporation with a capital stock of $50,000,000 is very interesting. In certain particulars the history of the one is very much like that of the other. Each company has passed through a series of changes resulting in a gradual increase of capitalization and a gradual extension of its business. The Edison company was organized on Oct. 17, 1878, and was then known as the Edison Electric Light Company. The series of changes through which this company passed until its final amalgamation in the early part of 1890 with the Edison Machine Works, Edison Lamp Company, and Bergmann & Co., to form the Edison General Electric Company, with capital stock of $12,000,000 are well known to our readers and need not be recounted here.

What has been known as the Thomson-Houston Electric Company was originally the American Electric Company and was organized in New Britain, Conn., in 1880. This company, like the Edison, has passed through a series of amalgamations with other companies, always retaining its own identity and merging the other company into its own organization. In this way the Brush, Schuyler, Van Depoele, Bentley-Knight, Fort Wayne, and a number of other companies have been brought under the Thomson-Houston management.

This final amalgamation, of which the General Electric Company is the result, places at the disposal of the new company probably one-half of all the electrical patents which have been granted in the United States in the last 15 years, and certainly more than that proportion of those which have any considerable value. The new organization has the control of the patents of Charles F. Brush, Elihu Thomson, Prof. E. J. Houston, Thomas A. Edison, Charles J. Van Depoele, E. Wilbur Rice, Jr., R. M. Hunter, Walter Knight, E. F. Bentley, and a score of other inventors whose patents on electric lighting, railway and transmission of power apparatus are among the broadest and most substantial.

CHAS. F. BRUSH.

Any organization which controls the patents of Elihu Thomson, Chas. F. Brush, Thos. A. Edison and Prof. Edwin J. Houston ought certainly to find itself in possession of a large number of the fundamental patents in the various branches of electrical application. These men have all taken a prominent part in the development of distinct branches of electrical work—Brush in arc lighting, Edison in incandescent lighting, and Thomson and Houston together in arc lighting, the transmission of power and general electrical apparatus.

Although the faces of these men are now quite familiar to many of our readers, we take this opportunity of presenting their portraits as the group of inventors whose patents are the foundation of the new company.

No one was surprised at the new company's choice of a president. It cannot be said that the success of the Thomson-Houston company is directly due to the exertions or skillful management of any one man, but so far as this is true it is well known throughout the entire electrical fraternity, and among the public as well, that the man whose position has given him the major part of the management of the company's affairs is Mr. Coffin. For eight or nine years, in fact, since the company was moved from Connecticut to Boston and Lynn, Mass., he has been the treasurer and general manager, and practically the chief executive officer. He has been more closely connected with the affairs of the company than the other officers, from dictating its policy in deals of the greatest magnitude and mapping out and successfully consummating the various departures that have characterized the rapid growth of the company down to the most careful knowledge and direction of the thousand and one details of such a large system, which were left to his large corps of assistants and clerks for final perfection.

As treasurer of the company he has conserved the interests of all stockholders by the general policy that has been pursued under his more immediate guidance, though, of course, at all times this came directly from the conservative and business-like Board of Directors that have always governed the company. Perhaps the wisdom of the financial policy of the company is best attested by the character of those directors who have more recently joined the board, representing as they do the most substantial banking houses in Boston and New York.

It has not been a management at all lacking in shrewd, far-sighted judgment that has successfully, and for the advantage of all concerned, brought within its own domain the interests of such other powerful, though smaller companies as the Brush, Fort Wayne, Schuyler and Van Depoele, all of which owned valuable patent rights which have since greatly strengthened the Thomson-Houston system.

A wise board of directors can do the vital part of the work in shaping the general course of a corporation, but to the general manager belongs the successful execution of all plans, and upon him largely depends their future profit to the company. Mr. Coffin's election to the presidency of the General Company is a just recognition of the work he has already done in the Thomson-Houston company. Larger demands will be made on his executive ability, and the experience of the past will have made him able to give the same wise direction and careful management to the new company's interests that has characterized all his work in his former position.

ELIHU THOMSON.

Eugene Griffin, the first vice-president, has been connected with the Thomson-Houston company for about four years, and during most of this time has been a director and vice-president. He has been closely identified with many of the more important contracts and deals of the company, and has proven himself to be in every sense well qualified for his new position, with a larger field in which to work.

EDWIN J. HOUSTON.

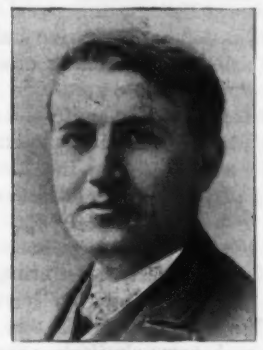
Samuel J. Insull, the second vice-president of the new company, has been regarded as Mr. Edison's representative in the business management of the Edison company's affairs for nearly ten years. He held responsible positions at Schenectady and elsewhere until called to the general management of the business of the Edison General company soon after its organization. He is so well known to those who have had dealings with the Edison company that his selection as Mr. Edison's representative among the financial managers of the new organization has not been a surprise.

For all the years that the Thomson-Houston company has been in Boston, about nine, Mr. Garfield has been the secretary, and he will still continue to hold that position in the new company. He was for many years also secretary of the Thomson-Houston International Company; and is a director or officer in all the companies in which the Thomson-Houston owns a large or controlling interest. Under his especial care have been the interests of the Thomson-Houston company in those companies, a part of whose securities were owned by the parent company. These have been advantageously disposed of through the different series, which have proved profitable to both the company and the stockholders. There seems to be no weak point in the Thomson-Houston company's system, and that part which is under the control of the secretary is as well managed and as efficiently administered in all respects as is any other. Mr. Garfield assumes this larger position with every qualification for the place, and with the great advantage of a most valuable experience and a commendable record.

A. S. Beves, the treasurer of the new company, has been connected with the Edison company since 1884, being associated at that time with Mr. F. S. Hastings, the secretary and treasurer of what was then the Edison Electric Light Company. In 1887 he became secretary and treasurer of the Sprague Electric Railway and Motor Company. About two years ago he was elected assistant treasurer of the Edison General Electric Company, so that the duties of the office to which he has just been elected are those which his long experience has well fitted him to perform.

The more careful attention to the accounts of the new company will devolve upon Mr. Peach, who has for about three years attended to the same important duties in the Thomson-Houston company. The position is one demanding closest attention to details in connection with the many debtors of the company, and it is in the hands of a man who has shown his capacity and value to be more than equal to the position, whose affairs he has for a time administered. He will continue his work in the new company almost without interuption, as his new position is practically the same as his former one.

The care of the cash and banking will be in the hands of W. F. Pope, who is an adept in this line of work, and thoroughly trained for the responsibilities of the position by his experience with the Thomson-Houston company. This has been his department in the Boston office for about six years. The Thomson-Houston company has accounts with twenty or more banks; and the handling and disposition of the funds of so large a corporation is something of no small magnitude. With the new company this will be a still larger work, and will be efficiently administered by the officer in charge.



THOS. A. EDISON.

J. P. Ord, who has been chosen comptroller of the new company, has been in the service of the Edison company about three years. In the latter part of 1889 he was elected comptroller of the Edison Electric Light Company and the allied interests, which were afterward merged into the Edison General Electric Company. He held that position until the recent election.

The auditor of the new company, E. Clarke, was interested in the Edison business in London as early as 1879. He came to this country in 1884 and entered the offices of the general superintendent and general manager of the Edison Company for isolated lighting, where he remained for two years. From there he went into the accounting department of the Edison Electric Light Company, where he stayed until July, 1890, when he was elected auditor of that company. In 1891 he became assistant to the comptroller of the company, a position he has since occupied.

Henry L. Higginson, one of the directors, is of the firm of Lee, Higginson & Co., which stands, perhaps, at the head of the banking houses in Boston. For about two years he has been on the board of directors of the Thomson-Houston company, and his entrance to the board was regarded with great satisfaction by the public, who were then becoming interested in the company's affairs as holders of the stock, for he was considered a most valuable acquisition on account of his conservative and experienced judgment.

T. Jefferson Coolidge, director, is another typical exponent of Boston's integrity, conservatism and wisdom in the management of large commercial enterprises. He is a director in more banks, trust companies and commercial corporations probably than any other capitalist in Boston, and his name gives character to any board.

F. S. Hastings has been connected with the Edison company in various official capacities since 1882, at which date he became secretary of the Edison Electric Light Company. Two years later he became treasurer of the same company. He was treasurer and assistant secretary of the Edison General Electric Company until his recent resignation to accept an important position in Chicago.

H. McK. Twombly, the chairman of the new board, is the son-in-law of Wm. H. Vanderbilt, and represents the large Vanderbilt interest in the consolidated company.

D. O. Mills is a banker of large experience, and has been connected with some of the boldest financial undertakings in the country. In 1878 he transferred his interests to the East and built in New York the Mills Building, one of the largest and finest office buildings in the business section of the city. This building, by the way, was the first office building to be equipped throughout with the Edison electric light.

SAMUEL J. INSULL.

J. Pierpont Morgan is a member of the well-known banking house of Drexel, Morgan & Co. His career as a business man dates from 1857, when he returned from Germany, where he had been attending the University of Göttingen, and entered the banking firm of Duncan, Sherman & Co. In 1860 he became agent and attorney in the United States for George Peabody & Co., of London which relation he has since held with that firm and successor, J. S. Morgan & Co.

The firm of Drexel, Morgan & Co. is also further represented in the new board by C. H. Coster, who is one of the younger members of that firm. Mr. Coster was once a clerk in the firm of which he is now a junior partner. He has been upon the Edison board of directors for several years, and is well acquainted with the financial management of electrical interests.

Earth Current Disturbances in Telegraph Lines.

BY WILLIAM FINN.

For some time past, and at intervals more or less periodic, serious disturbances due to earth currents have again been experienced on the telegraph lines of this country. A long period of immunity from these troublesome visitors had been enjoyed prior to Saturday, Feb. 18, on which date the first of the series of recent phenomena was observed. On the evening of that day a very brilliant display of aurora borealis was observed in various parts of the United States. During the day strong earth currents had appeared in many of the wires, being of sufficient strength on some circuits to completely demoralize the service. Their existence on the Western Union lines was first noticed about 8:30 A. M., by means of the sensitive galvanometers with which the Wheatstone automatic circuits are provided.

These galvanometers are used to balance with and also serve the useful purpose of enabling the receiving offices to detect whatever "bias" there may be on the distant transmitting apparatus through lack of proper adjustment, etc.

On this particular morning the bias was very pronounced and variable, and the sending offices were continually called upon to readjust their transmitters with a view to remedying the trouble, but all to no purpose. It was not until a number of other circuits became similarly affected that the real cause began to be suspected, and eventually, by grounding a number of wires at their opposite extremities, earth currents of considerable magnitude were found to exist in them. Some readings taken of their value at that time on a wire between New York and Buffalo showed a variation in current strength between 5 and 21 milliampères, representing a maximum difference of potential between those points of about 50 volts.

No subsequent measurements were made, but it is calculated that during the height of the storm (between 3 and 4 P. M.) the current strength exceeded 40 milliampères.

Circuits running east and west were more generally influenced than those extending in other directions; though the latter were by no means entirely free from interruption. It is worthy of note that during the course of the afternoon, when nearly all the wires between New York and San Francisco were completely prostrated, a Wheatstone automatic circuit between Chicago and St. Louis—or one running approximately at right angles to the easterly and westerly line—worked at a high rate of speed without apparently any interference whatever. Scarcely any disturbance was noticed on the New Orleans automatic circuit until about 4:30 P. M., after which time this, as well as other lines north and south, became more and more affected, until it was possible between 7 and 8 P. M. to work the circuits with the earth currents alone, as was actually done in one or two instances.

The storm disappeared—or at least ceased to influence the regular working—shortly after 8 P. M.

From information received it appears that the magnetic storm began as early as 12:40 in the morning, as shown by the magnetographs in the observatories at Washington and Toronto, and that between midnight and morning, as well as during the evening of that day, a fine red aurora was visible.

A less vivid auroral display occurred on Sunday evening, March 6, and several instances are recorded of interruption to the telegraph service during the prevalence of the aurora, especially on circuits west of the Missouri River. On Saturday afternoon March 12, there was a recurrence of the phenomena, but telegraph circuits were affected to a limited extent only, and in a direction mostly east and west.

It is a singular fact that the Morse instruments were to all appearances indifferent on this occasion to the earth currents, which appear to have acquired an intensity sufficient only to visibly affect the comparatively weak signaling currents of the automatic system.

On April 24, 25 and 26 similar occurrences, but more spasmodic in character, interfered to a greater or lesser extent with certain wires running as usual in an easterly and westerly direction.

Since that time nothing further has been heard from them, though it is not in the least likely that we are altogether rid of their unwelcome visits, judging from past experience.

It has been demonstrated beyond all question that the closest relationship exists between the condition of the sun's surface on the one hand, and earth currents, auroras, and the phenomena of terrestrial magnetism on the other.

In September of the year 1859 a bright spot broke out on the face of the sun, and exactly at the same time telegraph wires and magnetic needles in all parts of the world were disturbed, followed by auroral displays. In February and August, 1872, and again in August, 1880, similar phenomena occurred.

The electric storm of Jan. 31, 1881, which was quite cosmical in its character, developed earth currents of remarkable intensity. On the same day a disturbance of unprecedented magnitude was observed in the sun's photosphere, one of those violent phenomena of solar excitement which occasionally become visible during the maximum sun spot period.

We are passing through that period now, and the usual results may therefore be anticipated for yet some time to come.

In view of this circumstance, it may be interesting to discuss one or two of the most plausible theories advanced by scientists to account for these strange and mysterious visitations.

It has been proved by the result of careful observation made upon the electrical condition of our globe, that the air is always more or less charged with electricity, so that the earth may be regarded as a highly electrified sphere with electrostatic lines of induction radiating from it in all directions into space. It may be accepted as highly probable that the sun and other members of the solar system are similarly charged to a greater or lesser extent; and that between all planetary bodies an electric force is exerted which varies with their respective charges and the distance separating them.

Now, any alteration in the static distribution of electricity upon a conductor will set up an electric current in it, so that the earth in its motion relatively to, say the sun, will have its electricity continually in motion, thus giving rise to electric currents. Under ordinary circumstances these currents would undergo regular periodic changes corresponding with the variations in the relative densities and distances between the charged bodies, but, under exceptional circumstances, when great and sudden changes are occurring in the solar atmosphere, we should expect to find

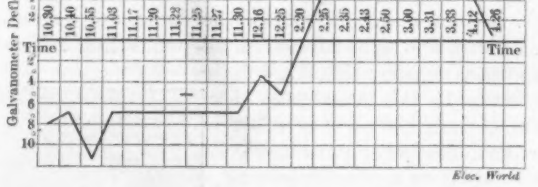


FIG. 1.—NORMAL EARTH CURRENT VARIATIONS.

sympathetic fluctuations in the magnetic field between the earth and the sun, which would create the conditions requisite for the generation of strong and variable earth currents.

The cause of these periodic solar perturbations is still a matter of conjecture; but, since they are so intimately associated with earth current phenomena, it is not improbable that a study of the vagaries exhibited by the latter may lead to a better understanding of the nature and cause of the former.

It is partly on this account that so much scientific interest is attached to the recurrence of these phenomena, and why it becomes a matter of considerable importance to collect such data and information as can be secured from observations of their effects upon telegraph lines. Records of the recent storms, for instance, show that, generally speaking, the wires proceeding north and south were not nearly so much excited as those extending in other directions. This fact affords us some idea regarding the distribution of the equipotential surfaces in this section of the globe; or, in other words, indicates between what points the electric potentials were nearly, if not quite alike; making it possible to deduce therefrom the direction taken by the originating disturbance.

To make this statement perfectly clear, let us consider what happens when a stone is dropped into a pool of water. By observing the waves on the surface of the water as they

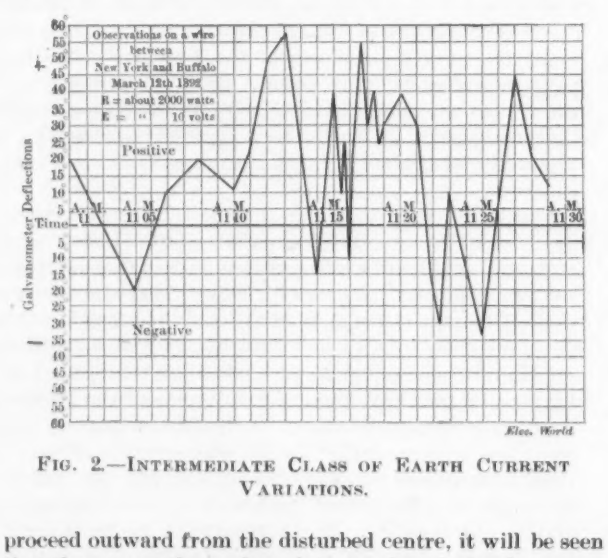


FIG. 2.—INTERMEDIATE CLASS OF EARTH CURRENT VARIATIONS.

proceed outward from the disturbed centre, it will be seen that they carve the surface into a series of circular waves alternately depressed and elevated. If you select any particle forming a portion of one of these waves it will be evident that it will form part of a circle of particles all at the same height as itself, and equally distant from the centre of disturbance.

Between any two points on this circle, therefore, there will be no tendency for water to flow.

Moreover, it will be equally evident that the disturbing force acts across these circles in a direction perpendicular to their surfaces.

Now the equipotential surfaces created in the case of an electric force may be likened to the series of concentric circles set up by the water disturbance. A body electrically excited may, in fact, be regarded as a centre of disturbance from which lines of electric force radiate in all directions.

At any distance from this centre a circle may be drawn, all points of which, being equally distant from the centre, will be at the same electric potential.

Hence, such a circle will represent an equipotential surface, along which there will be no tendency for electricity to flow. If, then, we find upon the surface of our globe a number of places connected by telegraph lines, where the effects of the late storms were less marked than on others, or between which no disturbing influence whatever was felt, we should be justified in regarding such points as near the line of, or actually forming parts of, equipotential surfaces.

Such is the deduction drawn in the case of those circuits which are least affected by the late electric storms, and these circuits were found to run mostly north and south; since electric forces always act across, or at right angles to the equipotential surfaces, it is possible to mark the direction taken by the propagating force and finally to trace it to its origin.

In this way it has been shown beyond peradventure that the sun is mainly responsible for the appearance of those singularly erratic performances of an electric character, which are more prevalent during the period of maximum sun spots than any other time.

It is highly probably that at such periods something akin to volcanic eruptions are taking place in the sun.

It is a well-known fact that terrestrial phenomena of any such character are always accompanied by electrical discharges and displays, and that these volcanic forces are in some cases characterized by having periods of considerable regularity. This is what probably happens on a much larger scale in the sun, the excited portion of whose surface is undoubtedly concerned in the production of those peculiar electrical and other phenomena which occur in eleven year cycles, as well as at other intervals both regular and irregular.

There are other currents of natural electricity which may be found in any telegraph wire at almost any time (by inserting a suitable galvanometer in the wire), that are the very antitheses of the intense and fitful currents we have just been considering.

These are the normal earth currents, which differ from the abnormal ones in several particularst. They are not transient visitors like them, but permanent residents in the earth. They are very much less intense and variable, show greater regularity in their fluctuations, and appear to be controlled by some invariable and general law. Early observations showed that these currents ebb and flow in a manner like the tides of the ocean, which led many investigators to suppose the cause to be of lunar origin. It was believed, for example, that this tidal action was brought about by the earth's electricity following the moon in her relative motion with regard to places on the earth's surface.

A striking confirmation of this view is apparently afforded by the record of some observations on earth current variations made upon the Atlantic cable in 1858. Readings, showing the directions and strength of the current flowing through the cable, were taken once every 15 minutes for a period of 36 hours, and compared with the tidal variations during the corresponding period. The curves showed a remarkable coincidence between the earth current variations on the one hand, and the times of high and low water on the other, from which it was argued that the same force which directed the tides was also concerned in the production and variation of earth currents.

I shall not attempt to dilate upon the many other interesting and characteristic features of these normal currents, but proceed to discuss another class of earth current that is not so well known and which exercises somewhat of a discriminating effect upon the working of circuits.

The abnormal earth current is one whose presence is readily detected on account of its decided action upon the working of the circuit.

The normal earth current, on the other hand, is exceedingly feeble, and does not, as a rule, affect the working in the least. (Fig. 1.)

What may be termed the intermediate class of current is one whose strength does not bring it within the range of visibility, as it were, of the ordinary Morse apparatus, and whose existence is not, therefore, even suspected; but which has, nevertheless, a disquieting effect on Morse circuits, as well as more serious consequences upon other circuits equipped with apparatus of greater susceptibility. This was particularly evident in the case of the storm of March 12, which, as previously mentioned, interfered in a marked degree with the operation of the automatic system without apparently affecting the working of the Morse wires.

This circumstance placed the automatic service, and those connected with it, in rather an unfavorable light, but when the real cause of the trouble was found, it was also discovered that though there had been no actual stoppage on the Morse circuits, there had been considerable bad working, which had been attributed to everything but the proper cause.

The result of some earth current readings obtained on a wire between New York and Buffalo on the morning of that date is graphically shown in Fig. 2.

They were taken some hours prior to the advent of the storm referred to, and were probably much less intense than those subsequently encountered; but yet of sufficient strength and variation to account for the fluctuating "bias" and other annoyances which so perplexed and worried the chief s

in charge of the Wheatstone circuits at the time. The writer has many records, taken at various times, of such like variations in the value of earth currents, and while they rarely exceed four or five milliampères, they appear to be sufficiently strong to produce at least some of the unsatisfactory results mentioned.

It is quite certain that a great deal of the trouble experienced on telegraph circuits is never satisfactorily accounted for; and while it is not intended to hold up the earth current as a scapegoat for all the unaccountable troubles that telegraphy seems heir to, there is hardly a doubt that its influence is frequently exercised to a greater extent than is generally supposed.

Fluctuations of the "Zero Point" of a Sensitive Galvanometer.*

BY F. J. ROGERS, M. S.

The sensitiveness of a galvanometer with a single needle varies inversely as the strength of the magnetic field in which the needle moves. Therefore, in order to render such a galvanometer very sensitive, it is only necessary to make the magnetic field very weak. This is accomplished by so placing a regulating magnet that its field almost neutralizes the earth's magnetic field at a point where the needle moves. Any one who has used a galvanometer made sensitive in this way knows how the position of equilibrium, or the "open circuit zero point," shifts along the scale from hour to hour. On some days with a very sensitive galvanometer this variation from moment to moment is so great as to entirely mask the effects to be measured. The writer, having been considerably inconvenienced by this shifting of the "zero point," thought it worth while to make a study of the matter.

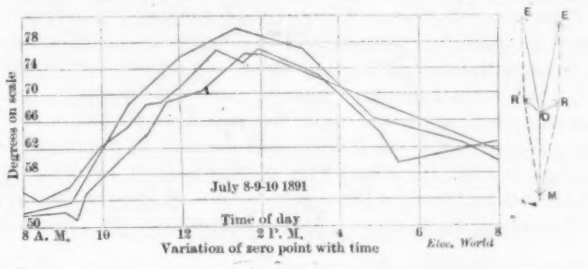
This phenomenon is obviously due to a variation of the magnetic field in the vicinity of the galvanometer needle, as there is no other variable factor. If the magnetic moment of the regulating magnet be constant, as is usually the case, and if there be no local magnetic disturbances, this variation must be due to a variation in the earth's magnetic elements. A reflecting galvanometer with a single needle was set up where the local magnetic disturbances were thought to be negligible, and made sensitive as above described. The position of equilibrium or "zero point" was then observed by means of a telescope and scale, for about every half hour during the day for three days. Curves *A*, *B*, *C* (Fig. 1) show the relation between the position of the "zero point" and time. Abscissæ represent times and ordinates the corresponding value of the "zero point." Beginning at about the same point at 8 A. M. each day, the "zero point" moved up the scale until 1 P. M., when it reached a maximum indicating a maximum westerly declination of the needle. From this time until evening the "zero point" dropped down the scale, and reached its original starting point on the next morning. The needle of another galvanometer in a different part of the building passed through a similar cycle. The motion, however, was not always in the same direction as in the first instrument. This is undoubtedly accounted for on the score of local influence, as the second galvanometer was not more than 30 feet from a series motor and its zero point was noticed to vary considerably when the current was turned on or off the motor.

The cycle of motions through which the galvanometer needle passed is the same as the diurnal variation of the earth's magnetic declination. However, the diurnal variation in declination is only 20 or 30 minutes, while the galvanometer needle moved through 10 degrees, or 25 times as much. Nevertheless it seemed highly probable that the phenomenon studied was due to this cause. To test this theory another galvanometer was set up about ten feet from the first one, but its needle was suspended in the earth's field, not in a weakened field. It then acted merely as a declination needle. The "zero points" of the two galvanometers were observed every 15 or 20 minutes for nine hours. When the curves for the two needles were plotted, as above described, it was found that the curve for the first one in the weakened field was almost an exact copy of the curve for the other galvanometer needle used as a declination needle, except that the ordinates of the former were about 20 times greater than the corresponding ordinates of the latter. That is the needle in the former case moved over an arc of ten degrees while in the latter case the arc was only .5 degrees.

To explain how the need'e in the weakened field magnifies the motion of the declination needle: let *O E* (Fig. 2) represent in length and direction the horizontal intensity of the earth's magnetism and *O M* represent the same quantities for the magnetic field of the regulating magnet in the vicinity of the galvanometer needle. In this case *O R* will represent in length and direction the resulting magnetic field, consequently the magnetic axis of the needle will be along the line *O R*. Now, if in any time, *t*, the direction of the earth's field varies from *O E* to *O E'*, the direction of the resultant field will vary from *O R* to *O R'*. From this it is obvious that if *O M* is very nearly equal to *O E*, then if *O E* moves through a very small angle, *O R*, and consequently the direction of the galvanometer needle will move through a very much greater angle.

In order to determine to what extent the shifting of the "zero point" is dependent on the variation in magnetic declination, the "zero points" of the two galvanometers above spoken of, the one with the needle in the weakened field and the other in the earth's field, were read every few minutes from 7 A. M. until 10 P. M., July 17, 1891. In Fig. 3 are given the curves showing the variation of "zero points" with time for the two galvanometers. The full curve corresponds to the galvanometer in the weakened field (whose horizontal intensity was $\frac{1}{24}$ that of the earth's field), the dotted curve *A* to the one in the earth's field; but in the latter case the ordinates are on a scale 25 times greater than in the former case. The dotted curve *B* represents the variation in magnetic declination for the same day as obtained from the continuous recording declination needle at Washington, D. C. The ordinates in this last curve are on a scale about forty times greater than the corresponding ordinates of the full curve. These curves prove beyond question that, local influences aside, the fluctuations of the "zero point" of a sensitive galvanometer are almost wholly due to variations in magnetic declination. It is further evident that changes in declination are almost identical at widely separated points and consequently that the "zero points" of galvanometers all over the country simultaneously pass through the same cycle of variations.

In this connection it should be added that the irregular changes in declination were on July 17 much greater than



FIGS. 1 AND 2.—FLUCTUATIONS OF THE ZERO POINT OF A SENSITIVE GALVANOMETER.

usual. Also on this day as well as on most days the magnetic disturbances were much greater in the forenoon than in the afternoon.

In the three cases in which the motions of the two galvanometer needles were observed it became, in the afternoon, more and more apparent that there was some other cause for the variation of the "zero point" besides the changes in declination. The needle still copied the motions of the declination needle, but its axis was generally more nearly in line with the declination needle than would have been expected from its motions in the forenoon. This is readily accounted for by the fact that the horizontal intensity of the earth's magnetism is also subject to a diurnal change, which reaches a maximum about 10 P. M. In Fig. 2 this would be represented by an increase in length of *O E* during the afternoon. The consequence of this would be that *O R*, the resultant field, would make a less angle with

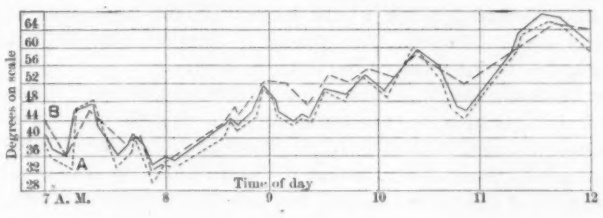


FIG. 3.—FLUCTUATIONS OF THE ZERO POINT OF A SENITIVE GALVANOMETER.

O E than would otherwise be the case. This is exactly what was observed. The inconvenience due to the shifting of the "zero point" may be avoided in three ways: (1) By working in the afternoon when magnetic disturbances are least; (2) by neutralizing the earth's field by means of a wrought iron case about the galvanometer as in Thomson's "ironclad" or marine galvanometer, and (3) by using an "astatic pair." In this latter case no regulating magnet need be used, and the "zero point" varies very little.

Electric Conduit Road in the City of Budapest.

While in America the trolley system has been perfected and is being introduced on a large scale, in Europe experiments have been going on to perfect systems which overcome the objections made to the trolley wires in the hearts of large cities. Among these European roads there is one in the city of Budapest, which has apparently been quite successful, although so far it has been introduced in only one city. It is an underground conduit road, with an open-slotted conduit resembling that of cable lines. As the builders, Messrs. Siemens & Halske, of Berlin, have just established a branch house here in this country, it is not unlikely that a similar one will before long be introduced here. A description of this road may therefore be of interest.

In our issue of Oct. 24, 1891, page 304, there is an illustrated description obtained from the company who built the road. But as there have been rumors here that it had not been working satisfactorily, it was thought best to obtain the facts from an impartial party, and we therefore communicated directly with a special correspondent in Budapest, not connected with the company, from whom we have obtained the following additional facts, which are supplementary to the description already given in the article above referred to.

There are at present four lines running in that city, the first of which was started July 30, 1889, and the last of which was completed about a year ago; portions of it have therefore been running almost three years. The total length of track is 19.7 kilometres, or about 11½ miles. The larger part of the road has double tracks. The sharpest curve has a radius of 25 metres, and the maximum grade is 1.6 per cent. (not 16 per cent., which was a typographical error in our former article). The maximum speed allowable is 15 kilometres an hour, or about 9 miles, although 18 kilometres is allowed in some places: 10 kilometres is the limit in the densely crowded streets, while on crossings only 6 kilometres per hour is allowed. The cars are 6.2 metres in length and 2 metres in width; the weight, including one 16-h. p. motor, is 4.8 tons without passengers. The gearing is accomplished by means of chains. There are 53 motor cars and 8 trailers in use. Starting rheostats are secured under the floor of the car. The connections at starting are made by means of a contact cylinder capable of being moved from either of the two platforms for each direction. The motor has separate pairs of brushes, which are thrown on or off by the regulating device.

As will be seen from our former description, the contact rails in the conduit are made of angle irons, one for each polarity. The contact with the car is made by means of a sliding device connected directly with the car and dragged along with it. It consists of two cast iron parts similar in shape to the shuttles in weavers' looms, which are connected by means of flat springs to a wooden frame. This frame passes up through the slot, which is 33 millimetres, or about 1¼ inches, wide, and is fastened on the bottom of the car between the front and hind wheels, the slot being in the track itself, as was shown in our former illustration. In these frames are secured two well insulated copper cables which pass up to the binding post on the car. Of the stoppages that have occurred the majority have been due to the breaking of these frames; this seems to have been the weakest point in the system, but it does not seem that there would be any very great difficulty in designing these so that they will not be so frail.

The central station, illustrated in the former description, is situated in the middle of the system. A pair of feeder wires leads to each of the four lines; these are also underground and consist of Siemens cables lead covered and armored with a steel band. It appears, however, that they are not quite ample, for on Sundays when the traffic at some hours is very great, these cables are said to become so hot that they cannot be touched.

The boiler house covers a space of 165 square metres; it contains five boilers, each of 98 square metres heating surface, equipped with smoke consuming devices. The machine room covers an area of 42 square metres and contains three 100-h. p. compound condensing steam engines making 180 revolutions, driving three dynamos by means of rope belts. The interior of this station was illustrated in our former article. The voltage used on the system is 300. There are furthermore three 300-h. p. compound engines driving dynamos at 130 revolutions by direct coupling.

The dynamos are shunt-wound and connected in parallel to common bus wires, which are connected through the switchboard to the four sets of feeders, the switchboard containing all the necessary apparatus, including an automatic interrupter in each line to protect it from the effects of short circuits. Each has a ground indicator in the form of lamps which, even in the driest weather, are more or less bright. It is stated, however, that the leakage is only a few ampères. During rainy weather, but especially when the snow melts, in which case the drainage of the conduit is not quite adequate, the loss by leakage is said to be quite appreciable. It was only during the winter before last that interruption was caused by this.

The switches on the track are operated by hand. At these places as well as on crossings with another electric road, the angle irons are cut, being electrically connected with each other by bent cables. As the illumination in the car, with the exception of a single oil lamp, is by means of incandescent lamps, the light goes out for a moment at each of these crossings.

The daily papers have recorded a few interruptions. Chief among these are short circuits in the traveling sliding contacts. Such interruptions, however, last only for a very short time. The injured contact frames are removed through the covered openings left for that purpose next to the track, and the car is then pushed by the one following.

The road appears to be still in the possession of the syndicate, although it is said to be really owned by the firm of Siemens & Halske. The cost of the line is given quite differently by different parties. In one case it was stated to have been $28,000 to $33,000 per kilometre, making about $47,000 to $55,000 per mile, including the central station, etc., and certain repairs at the central station. It is estimated by one authority that the cost of the road alone is about $22,000 per kilometre, or about $37,000 a mile. We believe the makers give the cost at $20,000 per kilometre in Budapest, or about $35,000 per mile in this country.

It should be noted here that the system of street cleaning in Budapest is very good, which is an important point for such a road.

In the *Pester Lloyd* of April 3, there is a report of an accident on this road. It was, however, a collision between a locomotive of a steam road with one of the electric cars, and was not due to any electric parts. Although there were twelve passengers, none of them were injured. The only injury was in the case of the driver, who jumped from the car and thereby broke his leg. Although the car was badly injured the interruption lasted only ten minutes.

*From the Cornell *Crank*.

The Elementary Principles Necessary to Establish the Equation of Electromotive Forces for a Circuit Containing Resistance and Self-Induction.—I.

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

In its newness the theory of alternate currents has been developed this way and that, added to here and there, so that one must stop and consider the basis from which various conclusions are reached and the logical sequence by which such results are obtained. The object of this paper is to rapidly go over the elementary theory of electricity which is essential for the proper understanding of problems which arise in connection with alternating currents in circuits containing resistance and self-induction. No full discussion of such circuits will be entered into, but the well known elements of the subject are presented which enable us to obtain expressions for the energy imparted to a circuit, the energy dissipated in heat and the energy expended in the magnetic field. This will, therefore, establish the equation of energy and the equation of electromotive forces for circuits with resistance and self-induction.

If a needle is magnetized uniformly in the direction of its length and placed in iron filings, the filings are attracted to the ends of the needle and become attached thereto in clusters. The attractive power of the magnetized needle is apparently concentrated at the ends, which are called *poles*. The filings in the space around the magnet tend to gather in lines, called *lines of force*, extending from one pole of the needle to the other. Thus the magnet is seen to be surrounded by a *field of force*, in which the lines indicate the direction of the force at any point of the field. When a compass needle is placed in the field it always assumes a definite position, tangent to the line of force passing through that point. The earth acts like a huge magnet, producing a magnetic field in which the lines of force have a direction nearly north and south. A magnetized needle freely suspended in the earth's magnetic field assumes a definite position tangent to the earth's lines of force. This position is usually nearly in the geographical meridian, the magnet having one pole toward the north and the other toward the south. The pole that is toward the north is called the positive pole, marked +; and the opposite pole the negative, marked —. When magnetic poles are brought near one another there is found to be either an attraction or a repulsion between them, and two poles which have the same sign tend to repel one another, while two poles of opposite sign tend to attract one another. The definition of a unit magnetic pole would therefore naturally be: a magnetic pole which exerts a force of one dyne upon another equal pole at a distance of one centimetre.

Such a magnetic pole as this just defined forms the foundation upon which is based the whole system of electromagnetic units, those of current, electromotive force, etc., and therefore deserves attention.

This definition depends upon the exact measurement of the distance between two poles. But in reality magnetic poles have finite dimensions and it is necessary to determine the mean distance between them. The distance taken is that between two points so situated that the action between the two poles would be the same if they were concentrated at these two points. We therefore think of a magnetic pole as concentrated at a point. This conception is no more strained than the conception of centre of gravity of a body where we consider the whole mass of the body as concentrated at a point.

The length of a compound pendulum is measured in a similar way, by considering that the mass of the pendulum is concentrated at such a point that the time of oscillation is not changed.

The law of the action between magnetic poles, as experimentally determined by Coulomb, is that the attraction or repulsion between two poles is inversely as the square of the distance between them, and directly as the product of their strengths, that is

$$F \propto \frac{m\,m}{r^2}$$

where m and m' are the strengths of the poles, that is, the number of unit poles to which each is equivalent, and r the distance between them.

A unit pole being as previously defined, the sign of variation may be changed for one of equality if the distance r is measured in centimetres and the force F is measured in dynes. The force between two magnetic poles is then

$$F = \frac{m\,m'}{r^2}$$

When the poles considered have the same sign, and are both north poles or both south poles, the product $m\ m'$ is positive, and a force of repulsion has the positive sign. Similarly, a force of attraction has a negative sign.

The strength of a magnetic field of force at any point is measured by its action on a unit positive magnetic pole at that point.

If we could place a free magnetic pole in a magnetic field, it would always be urged in a certain direction; and, if free to move, would actually move in this direction. The direction in which a positive pole would be urged is called the positive direction of the line of force which passes through the pole. The force with which a unit positive pole would be urged at any point of a magnetic field is the strength of the field at that point, which is usually denoted by **H**.

Usually it is found that **H** varies at different points in the field, but if **H** has the same value, both in magnitude and direction, at every point, the field is said to be uniform.

If the uniform field be one of unit intensity, and **H** = unity, there is said to be one line of force per square centimetre, and when the intensity is **H**, there are **H** lines of force per square centimetre. Thus the intensity of a magnetic field is thought of as being determined by the number of lines which pass through one square centimetre of a surface normal to the direction of the lines of force.

As an example, by the definition of a unit pole the intensity of the field **H** is unity at a distance of one centimetre from the pole. If a sphere be described about the unit pole as a centre, having a radius of one centimetre, there is consequently one line of force passing through the surface of the sphere for every square centimetre. As the surface of the sphere contains $4\ \pi$ square centimetres, there are in all $4\ \pi$ lines of force that emanate from a unit pole, and $4\ \pi\ m$ lines from a pole whose strength is m.

The number of lines of force in air is the same as the number of lines of magnetizing force. In a magnetic substance, such as iron, the number of lines of force is greatly increased, and they are then called lines of magnetization, or lines of induction.

The number of lines of induction N, passing through any area, is called the total magnetic induction through this area. The total number of lines of force per square centimetre of area normal to these lines is called the induction per square centimetre, or simply the *induction* **B**. In a non-magnetic medium the induction **B** is equal to the magnetizing force **H**. In a magnetic medium, such as iron, the magnetizing force produces an induction **B** greater than **H**. The ratio of the induction to the magnetizing force is called the *permeability* μ, that is $\mu = \frac{\mathbf{B}}{\mathbf{H}}$.

A current of electricity flowing in a circuit always produces a magnetic field in the surrounding region. The lines of force which constitute this field are always closed lines which encircle the conductor. The total number of lines passing through a closed circuit is the total magnetic induction of the circuit. As the current is increased in strength, the intensity of the magnetic field at every point is increased, and if there is no magnetic substance in the region, the intensity of the field is increased in direct proportion to the strength of current.

A unit current is defined in terms of the intensity of the magnetic field which it generates. A unit current is that which, flowing in a circuit of one centimetre radius, acts on a unit magnetic pole, placed at the centre, with a force of one dyne per centimetre length of the circumference. This is a unit of current in the C. G. S. system. Each unit length of conductor is acted upon by the unit pole, placed at the centre, with a force of one dyne, which is the same force as that by which a unit pole would be acted upon when substituted for a unit length of the conductor at the same distance. The practical unit of current, the *ampère*, is one-tenth of the C. G. S. unit.

We have seen that when a current flows through a closed circuit a field is set up consisting of a definite number of lines threading the circuit. If there is no magnetic substance in the vicinity, that is if the *permeability* of the surrounding region be constant, the number of lines produced by a current in a circuit is directly proportional to the current, and any change in the current produces a proportional change in the number of lines threading the circuit.

This may be expressed $N \propto i$, and $\frac{dN}{dt} \propto \frac{di}{dt}$. Since N varies as i, we may say

$$N = L\,i,$$

$$\text{and consequently } \frac{dN}{dt} = L\,\frac{di}{dt}.$$

The coefficient L is called the *coefficient of self-induction*, and is defined by the equation as the ratio of the total induction threading a circuit to the current producing it. When the current is unity the coefficient of self-induction is equal to the number of lines produced by the current. If the permeability of the medium surrounding the conductor is constant, this will be the value of L for all values of the current, and L will be constant. Unless a high degree of magnetization is reached, L is approximately a constant, and will hereafter be so considered.

When a conductor is moved in a magnetic field so as to cut lines of force an E. M. F. is produced in the conductor. Faraday showed as the results of his researches that the E. M. F. produced is directly proportional to the rate of cutting the lines of force, and is in a direction at right angles to the direction of motion and the direction of the lines of force. He further showed that, if the magnetic induction through any closed circuit be varied by any means, an E. M. F. is developed in the circuit proportional at any instant to the rate of change of the magnetic induction at that instant. In the C. G. S. system of units this experimental law may be expressed by the equation,

$$e = \frac{dN}{dt},$$

where e denotes the E. M. F. developed and N the magnetic induction of the circuit. This means that a C. G. S. unit E. M. F. is developed when there is a change in the induction of the circuit, at the rate of one line per second. The practical unit of E. M. F., the *volt*, is 10^8 times the C. G. S. unit just defined.

An electromotive force impressed upon a closed circuit causes a current to flow which depends upon the resistance of the circuit.

Ohm first showed, and others have since verified to a high degree of accuracy, that with a constant E. M. F. the current is directly proportional to the E. M. F., and inversely proportional to the resistance of the circuit.

Ohm's law may be expressed

$$I \propto \frac{E}{R},$$

when I denotes current; E, E. M. F., and R, resistance. Since E. M. F. and current are already independently defined, the unit of resistance is naturally taken to be that resistance which allows a unit current to flow in a circuit, having a unit impressed E. M. F. Ohm's law may then be expressed

$$I = \frac{E}{R}.$$

From the relation of the practical units of E. M. F. and current, the volt and the ampère, to the corresponding C. G. S. units, it follows that the practical unit of resistance, the *ohm*, is 10^9 times the C. G. S. unit.

A unit *quantity* of electricity is said to flow in a circuit when unit current flows for one second.

When a current I flows in a circuit for t seconds, a quantity $I\,t$ will flow. And in a short interval of time dt, a quantity $i\ dt$ will flow, which is represented by dq, thus,

$$\frac{dq}{dt} = i,$$

q representing quantity.

We have seen that for a constant electromotive force by Ohm's law the current equals the E. M. F. divided by the resistance. During a short interval of time dt, any E. M. F. may be considered constant, and we may write

$$i = \frac{e}{R} \text{ during the time } dt.*$$

When a closed conductor is moved from one position to another in a magnetic field, so as to cause the number of lines of force included by the circuit to change from one value N_1 to another value N_2, it will be found that the quantity of electricity which flows in the circuit is always a definite amount, being equal to the change in the number of lines $N_1 - N_2$, divided by the resistance of the circuit, and is entirely independent of the manner of the change, and of the time occupied in making the change.

This will be evident when we remember Faraday's law, $e = -\frac{dN}{dt}$, and consider that the only E. M. F. acting in the circuit during the motion of the conductor is this $\frac{dN}{dt}$. Hence the following relations are true,

$$\frac{dq}{dt} = i = \frac{e}{R} = \frac{1}{R}\,\frac{dN}{dt}.$$

$$\text{Whence } Q = \frac{N_1 - N_2}{R}$$

Here Q denotes the sum of all the small quantities, or the total quantity of electricity flowing through the circuit during the motion of the conductor, and is seen to be equal to the change of the induction through the circuit divided by the resistance of the circuit, as stated above.

The earth inductor is a good example of an instrument which depends for its use upon the principle just stated. When a ballistic galvanometer is connected with an earth inductor, the throw of the galvanometer is proportional to the total change in the number of lines of force included by the earth inductor coil as it turns from one position to another, provided the needle does not start to swing until the whole quantity of electricity has flowed through the galvanometer.

The fourth and last great experimental law to be mentioned is the discovery by Joule that the heat liberated by a conductor carrying a current of electricity is strictly proportional to the product of the square of the current strength and the resistance of the conductor.

Now for the first time we have a means of telling how much energy is required to send a current of any desired strength through a conductor, and we always expect to find some source for the supply of energy when we see a current flowing through a conductor.

The elementary principles, already given, upon which the system of electromagnetic units is based, are deduced from the experimental researches of Coulomb, Faraday and Ohm. When a current flows through a conductor there is always heat liberated in the conductor and accordingly a dissipation of energy. It therefore requires a certain amount of energy to send a current through a conductor. The exact amount of this heating effect was first determined by Joule. The results of his experiments show that the energy liberated in the form of heat in a conductor carrying a current of electricity is strictly proportional to the product of the square of the current strength and the resistance of the conductor. Joule's law may be expressed,

$$W \propto I^2\,R,$$

where W represents the energy expended per second.

The energy expended in the time t, during which the current is constant, is $I^2\,R\,t$. If the current be a variable i, it may be considered constant for the time dt, and so in the time dt

$$\text{Energy dissipated in heat} = i^2 R\,dt.$$

When *all* the energy given to the circuit is expended in heat, that is when there is no counter E. M. F. of any kind and the current is constant, $I\,R$ may be replaced by E, ac-

* In this paper the capital letters E, I and Q will be used to denote a constant electromotive force, current or quantity. When these are variable the small letters, e, i and q will be used.

cording to Ohm's law, and the energy expended per second may be written

$$W \propto E I.$$

This may be found also from the units already discussed. If a conductor carrying a current I be placed at right angles to the lines of force in a uniform field of intensity H, each unit of length will be acted upon with a force $\mathsf{H} I$. If l be the length of the conductor, the force will be $l \mathsf{H} I$. When moved with a velocity v against this force, work will be performed at the rate of $l \mathsf{H} I v$ ergs per second, or

(1) $$W = l \mathsf{H} I v.$$

This must be equal to the rate as which work is done in generating a current I by moving the conductor through the field. The conductor, when moving with a velocity v, cuts $l \mathsf{H} v$ lines per second, and so produces an E. M. F.

$$E = l \mathsf{H} v.$$

Substituting in (1) above, we see that the rate at which energy is expended in a circuit at any time is equal to the product of the current and the electromotive force at that time,

$$W = E I.$$

This is seen to be equivalent to Joule's law above. In the C. G. S. system, energy is measured in ergs. The joule is the practical unit of energy, and from the relation already given between the ampère and volt and their corresponding C. G. S. units, the joule equals 10^7 times the C. G. S. unit, the erg. The rate of work is in electrical terms expressed in watts: one watt equals one joule per second. The common English unit of rate of work is the horse power: one horse power equals 745.9 watts.

The rate at which energy is imparted to a circuit multiplied by the time is the total energy imparted during that time. If there is a variable E. M. F. e from any source whatever given to a circuit, and a current i flows, the energy imparted to the circuit in the time dt from the source of this E. M. F. is the product $e\,i\,dt$. Thus:

$$\text{Energy imparted to a circuit} = e\,i\,dt.$$

This enables us to ascertain the energy possessed by a magnetic field. By Faraday's law, when the magnetic induction through any closed circuit changes from any cause whatsoever, there is always an electromotive force given to the circuit which is equal to

$$e = \frac{dN}{dt} = L\frac{di}{dt}.$$

This E. M. F. is due to the existence of the magnetic field. The work which the force does is equal to the product of the force, the current which flows in the circuit and the time dt, as explained above. The change in the energy possessed by a magnetic field in the time dt is therefore,

$$i\frac{dN}{dt}\,dt = L\,i\frac{di}{dt}\,dt.$$

$$\text{Energy expended in the magnetic field} = L\,i\frac{di}{dt}\,dt.$$

The change in the induction through any circuit may be due to any external cause, or it may be due to a change in the current itself. When the change is due to the current an increase in the strength of the current increases the energy of the magnetic field; and positive work is done by the current in creating the field. When the current decreases the energy of the field decreases, and negative work is done by the current on the field, for, when the current decreases with the time $\frac{di}{dt}$ is negative. To say that the current is doing negative work is equivalent to saying that the magnetic field in decreasing is imparting energy to the circuit. Thus we see that the energy may be stored up in a magnetic field, and that this is not dissipated, but is returned to the circuit when the field is diminished in strength.

To find the expression for the total energy of a magnetic field which is due to a current i flowing in a circuit, we need merely find the sum of all the small quantities of energy imparted to the field as the current is increased from zero to its final value i, this is found to be

$$\int_0^I L\,i\,di = \tfrac{1}{2} L I^2.$$

TO FIND THE EQUATION OF ENERGY.

If e represent the impressed E. M. F. given to a circuit which has a resistance R and coefficient of self-induction L, we have seen that the total energy given to the circuit from the source is $e\,i\,dt$.

A part of this energy supplied is dissipated in heating the conductor, and in the time dt is equal to $R\,i^2\,dt$. A second part is stored up in the magnetic field, and in the time dt is equal to $L\,i\frac{di}{dt}\,dt$. These two ways are the only ones in which the energy of the source is used, under the hypothesis made that the circuit contains no statical capacity or counter electromotive force of any kind other than that due to the field, but only contains a resistance R and a coefficient of self-induction L.

By the principle of the conservation of energy we may, therefore, say that the energy supplied to the circuit is the sum of the energy dissipated in heat and the energy expended on the field.

We have, therefore, the equation of energy:

$$e\,i\,dt = R\,i^2\,dt + L\,i\frac{di}{dt}\,dt.$$

When each member of the equation of energy is divided by $i\,dt$, we obtain,

$$e = R\,i + L\frac{di}{dt}.$$

This is an equation of electromotive forces, e is that of the source impressed upon the circuit, $R\,i$ the E. M. F. necessary to overcome the ohmic resistance, and $L\frac{di}{dt}$ the E. M. F. equal to the E. M. F. of self-induction.

In some subsequent papers the further discussion of circuits containing resistance and self-induction will be given, after which will follow a similar discussion of circuits containing resistance and capacity.

Methods of Electrically Controlling Street Car Motors.*

BY F. H. PARSHALL.

The three curves in Fig. 5 are for single reduction motors with commutated fields. No. 1 is for a 25 h. p., No. 2 for a 15 h. p., and No. 3 for a 20 h. p. motor. The pull at the car wheel for the more important points is given, since without this such curves of efficiency and horse power of street car motors are of but little value. It may be well to state that it has been found possible to increase the limits of the high efficiency part of the curve by modifying the construction of the armature core so as to diminish the losses by hysteresis and Foucault currents.

The discussion which followed the reading of this paper was to a great extent on the relative efficiencies of the geared and gearless motors, by the respective advocates of those two systems. No definite conclusions were arrived at in the discussion, owing apparently to the want of data. It seemed to be universally conceded, however, by all, that theoretically a gearless motor could be made as efficient as a geared motor, but that there were practical difficulties encountered in the actual construction.

Mr. Charles Hewitt claimed that the double reduction

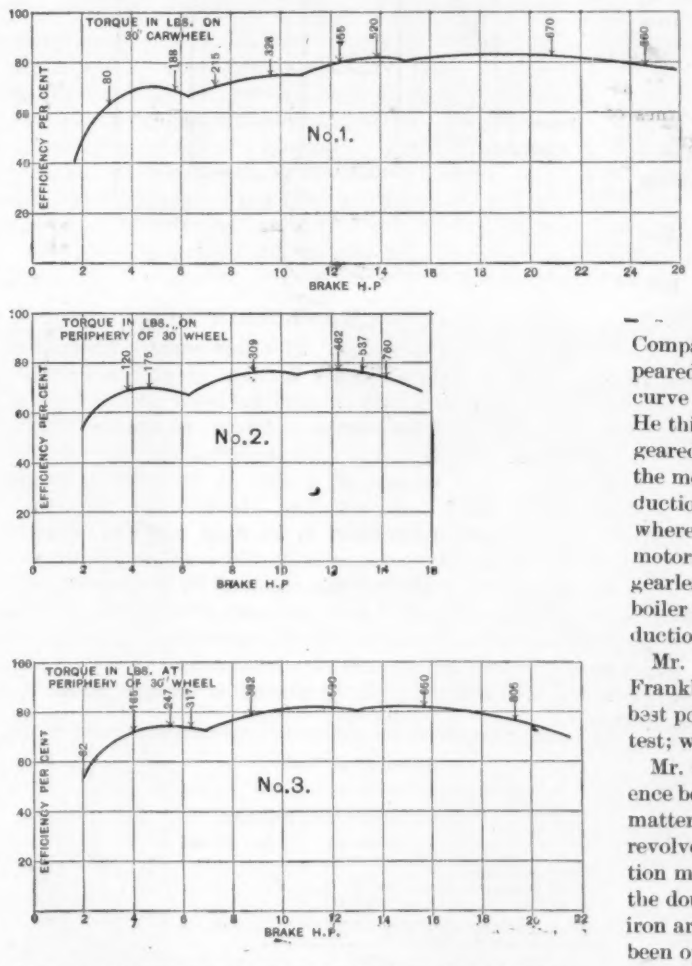


FIG. 5.—EFFICIENCY CURVES OF STREET CAR MOTORS.

motors were the most efficient, and that every departure that has been made from them had been a step backward, so far as efficiency is concerned, the gearless motor, he claimed, taking the most energy of all to accomplish the same result. He states that Mr. Short in his experiments started with his double reduction motor, whose maximum efficiency was no higher than that of his gearless, namely, 70 per cent. He first tested the motor without gears, then put on a single reduction of gears, and of course got a lower efficiency. Then he put on another reduction, and tested again, and of course he got a lower efficiency still. The misleading portion is that he used a motor of very low maximum efficiency.

A well-designed double reduction motor with commutated fields starts off with an average efficiency of 85 per cent. and a maximum of 88 to 90 per cent. Allowing 15 per cent. loss in gears, as shown by Mr. Short, the average efficiency at the car axle would be 70 per cent., which is as high as the maximum efficiency of Mr. Short's gearless motor. Regarding the cost of power, it was stated by some authorities that the coal consumption is a comparatively small part of the operating expenses of the road, and that, therefore an economy in power is not of such great importance, but Mr. Hewitt claimed that it is not only the extra cost of coal required for a less efficient motor, but also the extra increase in the size of the whole power plant required to be erected. He admits that with the No. 6 motor on an average road they could easily run 12 cars with a 100-kilowatt dynamo, whereas with single reduction motors they can run only eight, and with some motors only five or six cars. It makes a difference whether you have to install two 100-kilowatt dynamos to do a certain duty or one. It is not only the actual cost of the coal pile and the actual cost of attendance, but it is the increased cost of the plant. He claims that power plants have got to be built of almost double the size now that they were two years ago with the No. 6 motor, and that the double reduction motor will average an efficiency of about 85 per cent., while the average efficiency of the gearless motor is about 45 per cent. He claims to get with the double reduction motor an efficiency of 60 to 70 per cent. for the whole car equipment and feels confident in saying that if a gearless motor could be furnished which can operate with an average efficiency of 75 per cent. in actual practice, there never would be another geared motor sold. He does not deny that the gearless motor can be made as efficient as any other, provided there is unlimited space, and that unlimited iron and copper can be put in it. On a street car there is a limited space which must be conformed to, which is the reason why, perhaps, more iron and copper are not used. By using more materials the motor also becomes more expensive, which is a very serious point.

Mr. Charles P. Steinmetz stated that the term "efficiency" of a motor is a very indefinite term, and that we should therefore decide first what we mean by this term. Speaking of the loss in gearing, he said that in one case it amounted to 40 per cent. He claimed that they must be very wasteful, not only on account of rough usage, but also on account of the rain, dirt and dust; also because, as one of the gears must be a small pinion, it cannot be designed very efficiently. The fact that phosphor-bronze pinions are ground to dust and rawhide gears torn to fibres in a very short time is by itself a sign that much energy is consumed by them. Regarding gearless motors, he spoke of a number of test cards which showed an efficiency of 80 per cent.

Considering the absence of loss of energy in the gearing, he could not see how the double reduction motor can possibly be more efficient than the gearless. He states the average efficiency of a well designed gearless motor can be brought as high as 75 per cent. Tests made by an independent railroad company on such gearless motor showed that the highest efficiency reached a little over 80 per cent. Compared with other single reduction motors, what appeared to him as most remarkable was that the efficiency curve was very flat over a wide range beyond 70 per cent. He thinks that this falling off of the efficiency curve in the geared motor is due more to some defect in the design of the motor and is not essential to the principle of double reduction gearless motors. He spoke of a road in Toledo where they use both gearless motors and double reduction motors. The station superintendent found that if only gearless motors were used he consumed less coal under the boiler of the steam engine than when he ran the double reduction motors.

Mr. Townsend Wolcott, referring to some tests of the Franklin Institute on the efficiency of gearing, said that the best possible standard gears gave 90 per cent. in a laboratory test; with two reductions it would, therefore, be 81 per cent.

Mr. Charles G. Curtis stated that, as the principal difference between the geared and the gearless motor is merely a matter of speed, he did not see why a gearless motor which revolves at one-tenth the speed of the old style double reduction machines cannot be made to give the same power as the double reduction motors, provided enough copper and iron are put into it. He spoke of a gearless motor which had been operated for several months, and tested by impartial experts, who found that it took 16 ampères to make 18 miles an hour, while one of the regular Thomson-Houston cars required 28 ampères to make 17 miles an hour. Beyond a certain limit he says the gearing consumes an enormous amount of power; below that speed it consumes about 30 per cent. His experimence was that 30 or 40 per cent. are consumed at a speed of not over 15 miles an hour.

Prof. Dugald C. Jackson stated that it is questionable whether it is not best to permanently connect the motor armatures in series with each other and with their fields for such work. The starting and speed regulation can be very satisfactorily effected by a rheostat, while it is possible to put the fields of the two motors in parallel for fastest speeds. Practically this method of connecting has been used with excellent success. It retains the principal advantages maintained for two motors on each car, *i. e.*, added traction and decreased chances of trouble due to lack of harmony between the motors, and introduces no unnecessary complications.

While the magnetic and parasitic armature losses should be reduced with special care in street railway motors, at the same time the electrical resistances of armatures and field should with equal care be made the least that is consistent with meeting other requirements. Reducing the energy used in the rheostat by increasing the loss in the fields is not likely to meet universal favor, as it merely transfers the seat of trouble to a point more expensive to repair. Hence, rheostat regulation, with or without auxiliary commutations of fields, seems likely to prevail with the majority. With proper design, such as Mr. Parshall would give us, the auxiliary commutation of the fields may serve an excellent purpose in economizing weight of copper.

* This addition to Mr. Parshall's paper, read before the American Institute of Electrical Engineers and printed in our issue of April 30, was received subsequently to that publication. A synopsis of the discussion is also given.

Electro-Metallurgy.—III.*

BY F. M. F. CAZIN.

The pages of an electric journal cannot be considered as the proper place to discuss at length and render proof in a scientific method for the laws thus stated, but sufficient corroboration by well known facts may be quoted to render them acceptable.

The natural laws thus quoted are yet not sufficiently developed to permit of their exclusive use in calculating first, the caloric effect of chemical reaction, and vice versa, of electric energy required in electrolysis, but they serve the purpose well of assisting us in not only intelligently using the existing method of such calculation but also in critically verifying our results.

To show this, we will first have to discuss the prevailing method of such calculation.

Serving as the basis of all electrolytic calculation are the two values "Volt" and "Ampère."

In the preceding discussion it has been stated that the kinetic equivalent for E. M. F. is as

$$\text{Kinetic energy} = \frac{watts}{g} = \frac{volt\text{-}ampère\ (watts)}{9.81}$$

As the 1 volt is a product of 1 ohm × 1 ampère, this equation may even more properly be expressed as

$$\text{Kinetic energy} = \frac{ampère^2\ ohm}{g} = A^2 \times \frac{ohm}{g}$$

If this expression be compared to the one representing the (permanent) kinetic energy of (hydraulic) gravitation, the two expressions appear as analogous in

$$f \times \frac{v^2}{2g} \text{ and } A^2 \times \frac{ohm}{g}$$

(*f* signifying the transverse section of the water-jet) to the further extent of *f* and A^2 representing both an area (n^2), this is the transverse section of action in or of either force.

And the values $\frac{v^2}{2g}$ and $\frac{ohm}{g}$ appear as representing the one the hydraulic, the other the electric head of pressure,† which may properly be called also the quality of the total effect as such, while *f* and A^2 represent its quantity.

If *f* is analogous to (*C*) ampère, then *f v* (*v* being the distance of motion per second) in the equation for kinetic energy per second is analogous to the "coulomb." But electricians have so far a *name* only for this value representing the ampère-second but not a proper valuation, such as is shown in *f v*, which really represents a "volume" of the moving liquid in all of its dimensions, viz.: its area of action and its quantity (length) per second.

In this connection I beg leave to state that all of these discussions would be materially simplified had electricians followed the simple methods of mathematicians, mechanicians, and even of chemists, in using such expressions for modifications and units of electric energy, *E*, as would convey in common human parlance not only a full but also a precise understanding of what they desire to describe. If in place of "resistance," *R*, which by common understanding is the inverse of power applied, *P*, and a natural equivalent therefore, but not a factor therein, they would designate the "ohm" as a unit to measure electric quality (pressure, head or potential dimension), of electric energy, *E*: and if in place of "current," *C*, which by common use and understanding is, if not the whole of a moving volume of water, its velocity and indefinite in consequence, they would deign to designate the ampère as a unit of electric quantity, and the volt as a product of one unit of either, and treat the connection with time and its units the same as mechanicians do, or as the pillow of assumption on which all quantities of energy do and must rest in direct proportion—if they would thus employ parlance that is in harmony with the common run of human ideas and language, my task to speak intelligently also to men of other trades and professions would be eased, and, as I believe, be made more agreeable to them as a source of information.

A materialization of the relation between the two factors "resistance (ohm)" and "current (ampère)" and of their product the "volt" as represented in Daniell's cell has been accepted as normal. It is true that the volt to a certain degree is yet an ideal value, said to be equal to a hundred million of C. G. S., but it has found a practical representative in this Daniell's cell. We are told by the best of authorities that the E. M. F. of this cell is as 1.12 volts, or the product of 1 ampère in 1.12 ohm.

As this cell is essentially an electrolytic contrivance and for other reasons that will clearly be set forth further on, we have to thoroughly understand its working.

* For the first and second sections of this paper see THE ELECTRICAL WORLD, April 30 and May 7, 1892.

† If we assume, as a matter of illustration, that the unit (and name) by which distance be measured and called, be accepted as $\left(\frac{g}{2}\right) = (4.9\ m)$, and, as a consequence, that the value for the total distance of fall, acceleration of gravity, or force; "head under pressure" or for the inverse equivalent; "resistance" be expressed in kinetics as $S\left(\frac{g}{2}\right) = \left(\frac{v}{2}\right)^2$; in that case the electric equivalent for kinetic head would appear as

$$S\frac{g}{2} = \frac{ohm}{g}\cdot\frac{g}{2} = \frac{ohm}{2}.$$

And analogy would appear as between $\frac{ohm}{2}$ and $\left(\frac{v}{2}\right)^2$, the value for *S* under the same condition as to unit of distance. And by the equation $\frac{ohm}{2} = \left(\frac{v}{2}\right)^2$, we would also have:

$$\sqrt{\frac{ohm}{2}} = \frac{v}{2} \quad \text{and} \quad \frac{\sqrt{ohm}}{\sqrt{2}} = \frac{v}{2} \text{ and } \sqrt{ohm} = \frac{v}{\sqrt{2}} \text{ and } \sqrt{2\,ohm} = v,$$

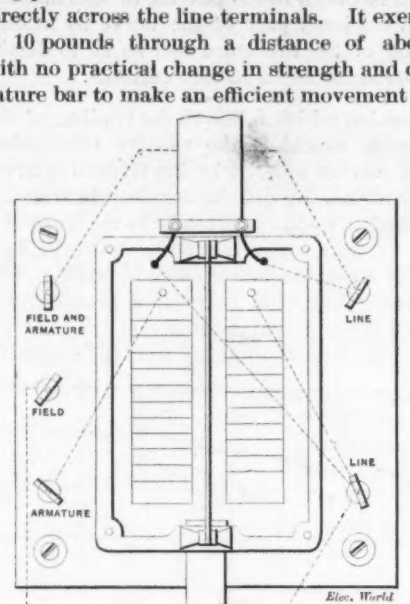
$$\text{or } 2\,ohm = v^2, \text{ and } 1\,ohm = \frac{v^2}{2}.$$

Resistance being the effect of two currents meeting, the dual value 2 ohm finds explanation, and a relation between velocity of gravitating matter and electric resistance becomes apparent.

The Whittingham Automatic Motor Starter.

The Automatic Switch Company, of Baltimore, has placed upon the market a new motor starter which differs essentially from the automatic switch starter manufactured by this company now well known through its extensive use. This switch has been very successful in connection with motors of the smaller sizes when used with care, but for the larger horse powers and for general use the company has now brought out the piece of apparatus illustrated on this page.

The action of the motor starter will be readily understood by an examination of the cut. The magnet which is the moving power of the device is shunt wound and connected directly across the line terminals. It exerts a pull of about 10 pounds through a distance of about eight inches with no practical change in strength and causes the iron armature bar to make an efficient movement throughout the length of its stroke. This movement is under the control of the dash pot at the bottom of the apparatus. When the armature bar has completed its stroke and reached the top contact of the resistance plate it is drawn firmly against an iron disc, which forms part of the cap of the magnet. By means of a disc it is possible to use a very small current to hold the armature bar with considerable force in its final position. This is considered an important point in the construction of the apparatus, for if the current required for the operation of the motor starter were also necessary after the motor had been started, the consumption of current would be so great as to offset the advantages of an automatic device of this kind. The reduction of the current is brought about by means of a carbon cut-out under the cap on the magnet, and the resistance of two Edison lamps is then thrown in series with the wire on the magnet when the armature bar strikes the iron disc. The magnet on the 220-volt motor starter has a resistance of 110 ohms when starting the motor and changes to 950 ohms when fully on.



CONNECTIONS OF THE WHITTINGHAM MOTOR STARTER.

Radiation of Heat from the Surface of Dynamo-Electric Machines.*

BY M. RECHNIEWSKI.

The dynamo-electric machine is able to furnish more or less energy according as it possesses more or less, and its output is not determined in as simple a manner as that of a gas motor or a steam engine. A continuous current electric motor never refuses a load unless beyond the normal; it only takes more current and heats until it burns and produces a break in the insulation, that is to say, a short circuit. I consider here only the electrical side, for it is evident also that mechanical accidents can happen, such as the gripping of the bearings, breaking of the shaft, etc. In fine, that which limits the output of most electric machines is the heating of the armature and the fields, and it is possible in a majority of cases to increase from 20 to 30 per cent. the output by better ventilation of the armature.

In most specifications the maximum heating above the surrounding temperature beyond which the machine must not go is stated; in some cases they go so far as not to allow a heating greater than 30 degrees, which is demanding much; but in most cases a heating of 50 degrees above the temperature of the surrounding air is admitted, which presents no danger.

The question of heating has then a great importance for manufacturers, since it is that which fixes the output, and consequently the selling price of the machine; and although each manufacturer has been obliged to consider this question of the heating of his machines, it is truly astonishing that there has not been any work published on the whole question, giving, for example, the number of square centimetres of cooling surface which it is necessary to give to an armature per watt transformed into heat in its interior.

That question is all the more interesting because the tests which I cite below show that the numbers vary from simple to triple, according to the geometric form and condition of the cooling surface. For certain armatures, eight square centimetres of cooling surface per watt transformed into interior heat are necessary, while for others, more open in form, three square centimetres are sufficient.

One sees by this the errors that can be committed in the design of new machines, if one admits always the same radiation per square centimetre. Some machines calculated upon that hypothesis cannot be economical and have more cooling surface than they can take advantage of.

In the test which follows, I calculate the work lost in the armature as follows: It is composed first of waste of current in the wire which is equal to $V^c \rho\, \delta^2$, where V_c is the total volume of copper wire on the armature, ρ the specific resistance of copper, equal to 1.6×10^6, and δ the current density per square centimetre; secondly, the work of hysteresis equal to $V^t N\sigma$, where V_t is the volume of iron upon the armature subject to magnetization; *N* the number of complete cycles per second, and σ the work of hysteresis per cubic centimetre and complete cycle. This work depends naturally upon the intensity of magnetization. I admit, in these tests, that it was proportional to the flux per square centimetre, and that for a flux of 10,000 per square centimetre it is equal to 10,000 ergs per cubic centimetre of iron and complete cycle. A number of tests made upon the same machines show that this method of calculation of interior losses was sufficiently exact.

The work transformed into heat in the armature is then in watts equal to $\Delta P = V_c P\rho\, \delta^2 + V_t N\sigma$.

In this study I have paid attention only to the armatures, for which the question of cooling surface has a much greater importance and for which the conditions vary very much more than for the fields.

Here are the results of experiments upon some machines of different output and form selected from many others.

Number of Test.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Type of Armature or Machine.	Drum.	Drum.	Drum.	Drum.	Manchester ring.	8-Pole.	8-Pole.	8 Pole.
Output in watts	3,300	5,750	26,000	33,000	18,000	36,000	30,000	23,700
Vol. of copper on armature in cms., Vc	440	1,100	2,880	3,072	2,466	5,040	5,040	5,040
Vol. of iron on armature in cms., Vf	1,100	3,200	10,389	9,150	12,300	12,700	12,700	12,700
Current density, ampères per sq. cm δ	500	330	329	470	350	330	400	300
Induction per sq. cm	17,000	17,000	17,000	17,000	17,000	10,000	10,000	10,000
Work of hysteresis per cu. cm σ	1.7×10^3	1.7×10^3	1.7×10^3	1.7×10^3	1.7×10^3	$\frac{1}{1000}$	$\frac{1}{1000}$	$\frac{1}{1000}$
Number of cycles, *N*	26	14	10	16	17	46	32	33
Works transformed into heat in armature in watts, ΔP	136*	269	683	1,332	829	1,650	1,710	1,146
Length of armature in cm	20	27	42	42	27	26	26	26
Diam. of armature in cm	12	175	27	27	36	Outside 5 Inside 25	50 25	5° 25
Area of cylindrical surface	720	1,450	3,400	3,400	2,970	3,900 1,950	3,900 1,950	3,900 1,950
Area of ends	230	550	1,840	1,840	1,880	1,590	1,590	1,590
Total cooling surface	950	2,000	5,240	5,240	4,850	7,440	7,440	7,440
Duration of test in hours	2½	2½	4½	3	4	3	3	4
Temperature of air at end of test (C°)	13°	7°	12°	13°	16°	15°	13°	15°
Temperature of armature at end of test (C°)	64°	53°	61°	67°	65°	51°.5	59°	42°
Excess of temperature of armature	51°	46°	49°	54°	49°	36°.5	41°	27°
Sq. cm. of cooling surface per watt	7*	7.4	7.65	3.93	5.85	4.5	4.35	6.5
Sq. inches of cooling surface per watt	1.08	1.15	1.118	0.65	0.91	0.69	0.67	1
Sq. cm. of cooling surface per watt for excess of 50°	6.9*	6.9	7.5	4.25	5.73	3.3	3.56	3.5
Sq. inches of cooling surface per watt for excess of 50°	1.07	1.07	1.16	0.66*	0.89	0.51	0.55	.54

*There is apparently some mistake here, perhaps due to an error in the published data.

I. The machine was run for two hours and a half, a sufficient time for a uniform temperature to be attained by these small machines, as preparatory trials showed.

IV. Same fields as the preceding, but an armature with interior ventilation. In comparing this with the preceding case we notice that the interior ventilation has increased the radiating power of the armature in the proportion of $\frac{7.5}{4.25} = 1.76$, that is 76 per cent.

V. The armature was closed on the pulley side by a metal plate, which prevented the air from entering the interior: the exterior surface of the armature and the two lateral surfaces can then only be counted.

VI. This armature is very well ventilated, the air easily penetrating the length of the shaft and escaping between the wires which carry the current to the commutator, so that the total surface exposed to ventilation is swept by an active current of air. Three tests were made with this machine.

* Translated and rearranged from the *Bulletin* de la Société Internationale des Electriciens.

VIII. The comparison between this machine and III. is particularly instructive, the output of the two machines being about the same. The open form of the ring of the multipolar machine makes it possible to utilize its interior surface for cooling, which has the effect of increasing the absolute dimensions of the cooling surface; the active circulation of air around the ring renders each square centimetre of cooling surface at least twice as effective as in the drum.

The influence of speed is scarcely appreciable within the limits in which I worked; the figures only vary to some tenths.

The temperature was measured by the application of a thermometer covered with padding to the armature immediately after it came to rest. This method gives very uniform results for the same test repeated many times. After the tests I have made, I can state that the Foucault currents were negligible for these machines at least. In driving them as a motor without load, for instance, and in plotting as abscissæ the speeds, and as ordinates the corresponding work absorbed by hysteresis and Foucault currents, I have always obtained a line almost straight, which does not pass through the origin, while if the Foucault currents were important that line would be very much curved at the top.

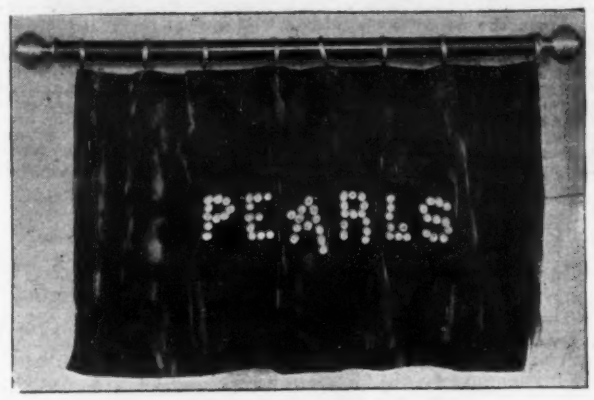
The Electric Light at the Actors' Fund Fair.

The supremacy of the electric light was never more plainly demonstrated than at the Actors' Fund Fair, which has just been closed at the Madison Square Garden. Lighting effects were produced which would have been utterly impossible by the use of any other illuminant than electricity, and which at the same time were more pleasing, more uniform and more easily controlled. The peculiar feature of the display was the wonderful subdivision of the light, which was carried farther than has ever before been attempted. The tendency of modern decorative lighting is decidedly in this direction and the results are certainly very satisfactory. For lighting purposes alone the employment of numbers of small lamps has many advantages, but in the field of artistic and novel decoration the small incandescent lamp is without a rival.

The fact that there were over ten thousand of these small lights of from two to eight c. p. will give some idea of the extent to which this idea has been carried. The novel arrangement and grouping of these lights, the attractive signs and curious effects were some of the most prominent features of the fair. Electricity vied with beauty to produce dazzling impressions and attract the attention of the throngs that continually crowded the floor.

The actual illumination of the booths was for the most part accomplished by small incandescent lamps, connected in series of two across the ordinary 120-volt three-wire mains, although some smaller lamps in series of four were used. These were provided with ground glass bulbs, and furnished soft, pleasing light in abundance. A good many electric candles deceived the unsuspecting visitor. In these the loops of the filament and the bulb were elongated in the shape of a candle flame, and a short distance away the effect was most realistic.

It was in the signs and ornamental peices that the most novel features appeared. Over the arch which faced the entrance were the words "Actors' Fund Fair" made up of glowing points of light. The tiny lights which formed these letters were connected in series of eight across the mains. In these larger signs each letter contained either eight lamps or some multiple of eight so that they might be independent of each other. They were mounted upon velvet covered blocks and set in a similar background, and it was a simple matter to change the letters so as to produce any desired word. At the other end of the room over the flower booth shone the name of Edison. Some of these signs were remarkably pretty, especially the "Chambers St. Theatre" and those which were displayed in one of the jewelry booths. In the latter the word "Rubies" was formed of little red lights on a background of ruby-red, while "Pearls" (Fig. 1) was represented by lights with semi-translucent bulbs which imitated the real jewels admirably.



A PEARL SIGN IN THE JEWELRY BOOTH.

In the Japanese corner (Fig. 3) was a screen on one half of which in lurid green was the word "Tea" and through a hole in the screen beside it protruded the head and shoulders of a smiling Jap. Perhaps the feature which attracted most attention was the electrical pin-wheel in the Shakespeare booth. On the face of a disc about three feet in diameter were arranged in appropriate circles a large number of the little lamps of various colors. The disc was revolved by a small Edison motor and by means of a commutator the lights were alternately extinguished and lighted so as to give precisely the effect of a pin-wheel. First the disc would appear of all one color, say red, the next instant it would be green and a second later another color or a combination of two colors would appear, and finally all the colors blended. To follow this with the eye and try to tell for any one instant just what colors made up this pretty combination was simply impossible.

The most artistic of all the electrical displays, as well as the most ingenious, was that which surmounted the inner side of the large arch. It was an immense fan (Fig. 2) which continually opened and shut. At one moment nothing was visible; the next a beautiful fan unfolded before the eyes of the wondering spectator. This was accomplished thus: The figure of the fan with its ornamentation was wrought out in the little electric lights of various colors, twelve hundred of them being required for this purpose. By means of a commutator turned by hand behind the screen the lamps were gradually cut out from the outer edges toward the centre, which produced the closing effect; to open the fan the lamps were cut in in the reverse order.

All of the artistic lighting on the floor was done by the Edison General Electric Company and reflects great credit upon the engineers who had it in charge. A disagreeable feature of past displays has been the appearance of the unsightly wires, but in this instance they were entirely concealed, which added much to the beauty of the whole. This practical demonstration of the possibilities of electric lighting in such small units will undoubtedly do much to advance decorative lighting.

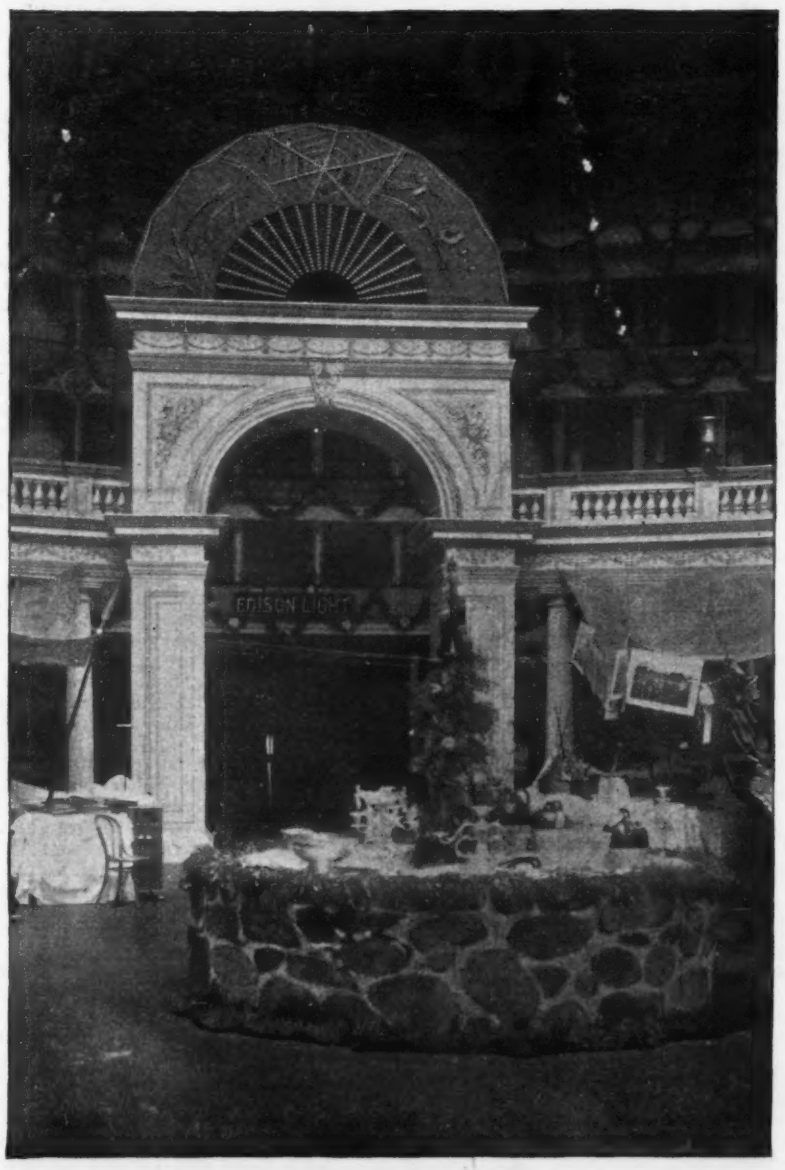


FIG. 2.—THE ELECTRIC FAN.

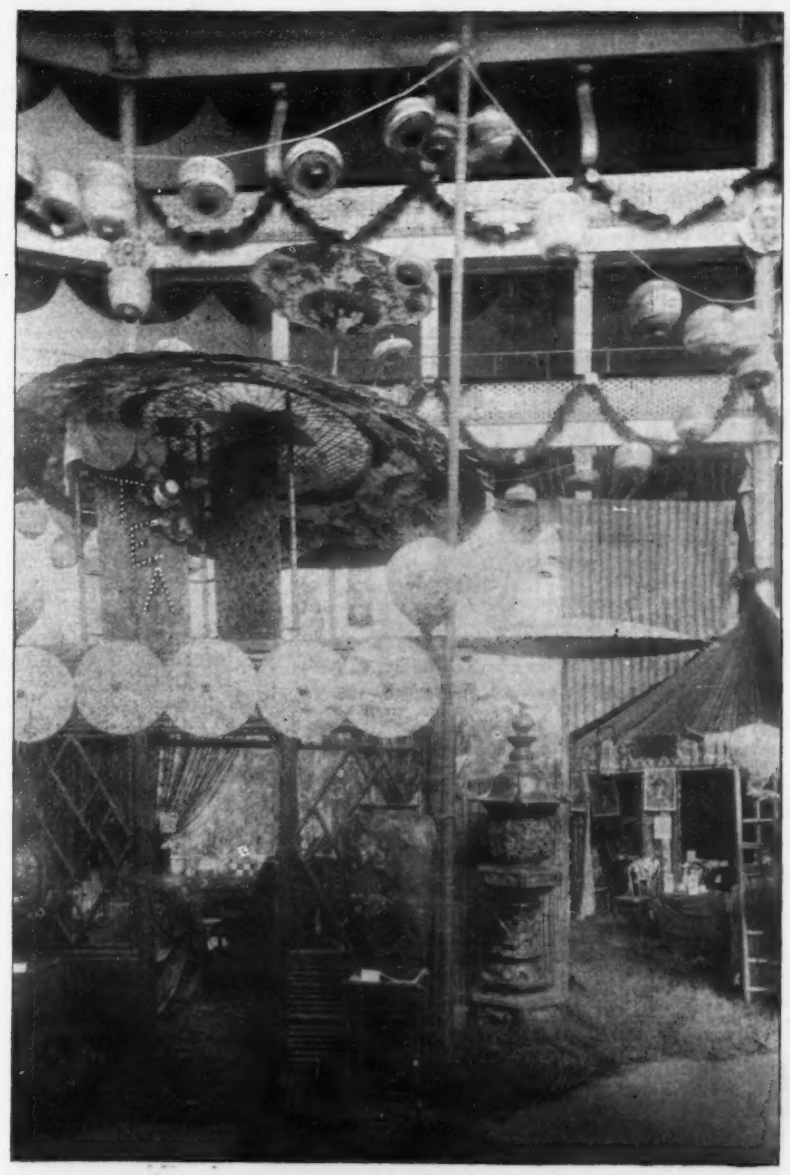


FIG. 2.—THE JAPANESE CORNER.

A Long Span Telephone Wire.

A subscriber who has read the note in the issue of THE ELECTRICAL WORLD of April 9 about the 2,400 foot span across the River Dart in England, calls attention to two telephone lines which cross the Ohio River between Portsmouth, O., and South Portsmouth, Ky., connecting the latter city with the Portsmouth telephone exchange. The wires at this point span the river from the pole on the Ohio side, measuring 102 feet above ground, to the Kentucky hills on the opposite side, the distance being 3,773 feet between poles. The wire is made of steel and its size is No. 12 gauge.

The Present Limitations of Electric Power in Mining.

BY IRVING HALE.

In my paper on "The Present Limitations of Electric Power in Mining," published in THE ELECTRICAL WORLD of April 9, the last half of paragraph following equations (*B*), (*C*), and (*C'*) should read as follows, the italicized portion being the part omitted. This omission makes it appear that the assumed variation of 276 volts would be excessive under any circumstances, whereas it might be a very moderate variation if the initial voltage were high enough.

"When it is necessary to use low voltage at a comparatively great distance, the application of equations (*B*) and (*C*) may give such a high percentage of loss in line as to be impracticable. For example, at 15,000 feet the line drop corresponding to minimum cost plant would be 276 volts, *no matter what voltage is used. If 1,000 volt motors are used, this would be allowable, but if 440 volt motors are required, they would be subjected to a range in voltage between full load and light load of nearly 276 volts*, or over 50 per cent., a variation too great for satisfactory service."

The New Edison Telephone Patents.

On Tuesday, May 3, the United States Patent Office issued three patents to Thomas A. Edison for a "Speaking Telegraph," the applications for which have been in the Patent Office for almost 15 years These patents appear to cover all telephones in which carbon is used, and they are, therefore, of great importance to the public. for if sustained they may give the Bell Telephone Company which holds them an additional term of years, during which it will have the monopoly of the telephone industry in this country. There are, however, widely different opinions among experts in patent matters as to whether these patents can be sustained, chief among which is the fact that some of the European patents for the same invention have already expired, and according to our laws the United States patents expire with the date of expiration of the shortest term of any of the European patents. It would appear, therefore, that the patents are already invalid.

A description of these patents as far as they relate to the carbon transmitter is given here, followed by some opinions of leading experts on the matter which we have solicited.

These three patents are all dated May 3, 1892. and are numbered 474,230, 474,231 and 474,232. The subject is "Speaking Telegraph." They are granted to Thomas A. Edison, and assigned to the Western Union Telegraph Company, of this city. It appears that all three of these are combined into one specification in the European patents, which were taken out in the following European countries:

In Great Britain, dated July 30, 1877, No. 2,909; in France, dated Dec. 9, 1877, No. 121,687; in Belgium, dated Jan. 11, 1878, No. 43,984; in Italy, dated Jan. 19, 1878, No. 9,791; in Spain, dated May 6, 1878; in Austria Hungary, dated Jan. 15, 1878; in Germany, dated Jan. 23, 1878, No. 14,308; in Russia, dated Feb. 15-27, 1882, No. 1,161. A patent was also taken out in Canada, dated Oct. 20, 1877, No. 8 026.

Patent No. 474,230 was filed April 27, 1877. The following is an extract from the specification, so far as it refers to the carbon transmitter:

"Telegraphs have been made to operate by sound, and the movement of a diaphragm has been employed to open and close an electric circuit. In cases where reeds or bodies following the law of the pendulum have been made use of the same respond to changes of tone and produce musical sounds. In telegraphs that are intended for transmitting spoken words there is a difficulty arising from those words generally being uttered in one key or tone, or nearly so, and hence they are not distinct and clear.

"This present invention I designate as a 'telespecan' or 'speaking telegraph,' because it is adapted to transmit spoken words regardless of the musical key.

"In the drawings Fig. 1 is a section of the transmitting instrument. . . .

"The resonators or sounding tubes or boxes *A B* are of any desired size, shape, or material. The box *A* is the one into which the words are uttered, and the box *B* or resonator is the responding part to which the attendant listens. The diaphragms *c d* are applied at the side or end of the respective boxes, and these should be provided with clamping-rings *e f* and tightening screws *g*, somewhat on the plan of a kettle-drum, so that the diaphragms may be of the proper tension. I prefer and generally use sheet metal for these diaphragms, which may be of suitable thickness, say one eighth of an inch, more or less, according to the size of the instrument. In front of the diaphragm *c* of the transmitter I make use of a second plate or a disc *n*. of suitable material, having a conducting service I have found that a disc of hard rubber coated with plumbago answers well; but a disc of some conducting metal or substance may be employed, or a plate of metal coated with some semi-conducting substance may be used. The circuit wires 3 and 4 from the line and a battery or other source of electricity are connected to this apparatus either at opposite sides of the disc *n*, or one wire may be connected to said disc *n* and the other to the diaphragm *c*.

"At the receiving instrument there is an electromagnet with its poles facing the diaphragm, and the armature is fastened to said diaphragm, or the diaphragm itself may form the armature if made of soft iron. The disc or plate is accurately adjusted to the proper proximity to the surface of the diaphragm, so that in a state of rest there will be little or no current passing from the battery upon the line; but the vibrations that are received by the diaphragm from the voice cause the electric energy on the line to increase and decrease, according to the intimacy of contact between the vibrating diaphragm and the surface of the adjacent disc, for if the electric conductors are connected to the diaphragm and disc, respectively, the current that passes will be pulsated and raised or lowered by

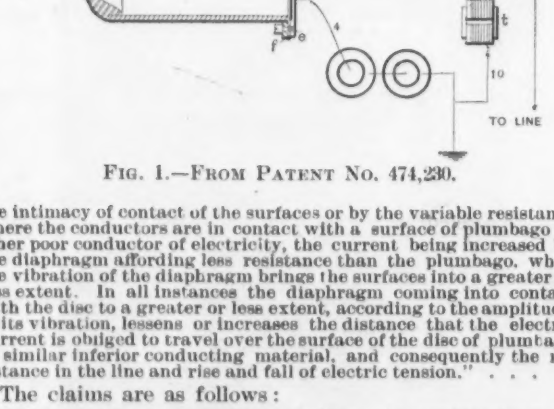


FIG. 1.—FROM PATENT NO. 474,230.

the intimacy of contact of the surfaces or by the variable resistance where the conductors are in contact with a surface of plumbago or other poor conductor of electricity, the current being increased by the diaphragm affording less resistance than the plumbago. when the vibration of the diaphragm brings the surfaces into a greater or less extent. In all instances the diaphragm coming into contact with the disc to a greater or less extent, according to the amplitude of its vibration, lessens or increases the distance that the electric current is obliged to travel over the surface of the disc of plumbago or similar inferior conducting material, and consequently the resistance in the line and rise and fall of electric tension." . . .

The claims are as follows:

"1. In a speaking-telegraph transmitter, the combination of a metallic diaphragm and disc of plumbago or equivalent material, the contiguous faces of said disc and diaphragm being in contact, substantially as described.

"2. As a means for effecting a varying surface contact in the circuit of a speaking-telegraph transmitter, the combination of two electrodes, one of plumbago or similar material, and both having broad surfaces in vibratory contact with each other, substantially as described."

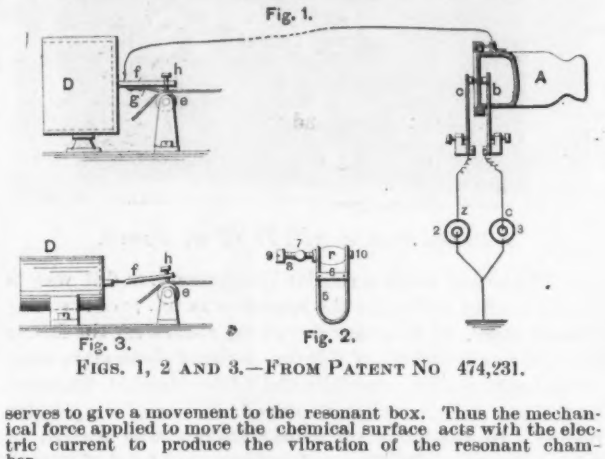
Patent No 474,231 was filed July 20, 1877; the following is an abstract of the specifications:

"The invention consists in the use, in the circuit of a speaking-telegraph transmitter, of one or more contact points formed of semi-conductors, such as plumbago, peroxide of lead and other oxides and conducting material.

"Fig 1 shows the transmitter and receiver. *A* is the resonant chamber, over the end of which the diaphragm is stretched, either side of which may be made heavier in the centre by a small weight if great amplitude is required of the diaphragm. *b c* are the two contact springs, having points made of compressed plumbago, mixed, preferably, with gum rubber; but any substance not liable to rapid decomposition may be used. These points face each other on the opposite side of the diaphragm and make contact with platina discs secured to the diaphragm. The spring *b* passes through a hole or small slot in the side of the transmitter; 2 and 3 are the main batteries. The battery 2 has zinc to the line or point *c* and the battery 3 has copper to the line or spring *b*. When the springs *c* and *b* are adjusted so as to make contact with the diaphragm equally, no current passes to the line; but when the diaphragm is vibrated its movement to one side —say *c*—causes a greater pressure upon the plumbago on that spring and a lessening of the pressure on the plumbago on *b*. Hence the balance of the batteries 2 and 3 will be destroyed; 2 being given the advantage, will send a negative current to line. Upon the return of the diaphragm the battery currents will again neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery 3 will send a positive current to the line. As plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak.

"In Fig. 2 is shown the contact-spring, which I prefer to use instead of *c* and *b*, which are used merely to assist in explaining the operations more clearly. *5* is a U-shaped spring secured to the screw 8, which is adjusted back and forward by the thumb-nut 9. 7 is the pillar holding such screws. *r* is a piece of soft rubber or equivalent substance placed between the prongs of the spring 5. 6 is a wire or band, which serves to bind the prongs tightly against the rubber *r*, so as to prevent the prongs acting as a tuning fork and transmitting harmonic vibrations not desirable. 10 is the plumbago contact-point. The object of the U-spring and rubber is to present a semi-rigid point for contact, so as to prevent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm. *D* is the receiver, which consists of a resonant chamber of any suitable character, either a tube, as in Fig. 3, or as a box, as at *D*, Fig. 1. *f* is a rigid arm secured to the box and is provided upon its extreme end with an adjusting-screw *h*. Near the end of the arm is secured a spring *g*. whose end rests upon the chemically prepared paper upon the drum *e*. The under side resting upon the paper is platinized. The screw *h* serves to increase and decrease the pressure of the platina spring upon the paper. When the paper is moved slowly by rotating the drum *e*, the waves of electricity coming over the line pass through the arm *f* to the platinized spring *g*; thence through the paper to the earth. If a negative current passes in the opposite direction, nearly all friction between the platina plate and the paper ceases, and the resonant box or diaphragm regains its normal position. When the positive current passes through the same channel, the normal friction of the paper is augmented and the chemical surface, acting upon the platina,

Fig. 1.



FIGS. 1, 2 AND 3.—FROM PATENT NO 474,231.

serves to give a movement to the resonant box. Thus the mechanical force applied to move the chemical surface acts with the electric current to produce the vibration of the resonant chamber. . . .

"In this specification no claim is made to the use of a spring for carrying one of the electrodes, since that invention forms the subject matter of an application, serial No. 192,456, filed as a division hereof.

"I claim as my invention—

"In a telegraphic apparatus operated by sound, the combination, with the diaphragm, of one or more contact points of plumbago or similar inferior conductor in the electric circuit, whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm, substantially as set forth."

No. 474,232 is substantially the same as the previous one, the figures being precisely the same, but it has in addition the following paragraphs, the claim, of course, being different:

"This application is a division of my application filed July 20, 1877 serial No. 141, and said division is made for the purpose of separating from the said original application the feature of invention, hereinafter claimed.

"This division of my said application relates to the combination, with a diaphragm against which the air waves act, of a spring forming or carrying one electrode and constantly pressing against the other electrode to maintain the required pressure and to yield to the movements of the diaphragm.

"The apparatus shown in the drawings and hereinafter described not only embodies the said invention, but also other features not claimed herein, but which originally formed subjects of claims in my said original application. The particular form of receiver shown and described is not essential to the invention herein claimed.

"When only one of these contact points is used in combination with the diaphragm, the vibrations of the diaphragm cause a greater or less pressure upon that point, and the strength of the electric waves will be varied in propoction to the movements of the diaphragm actuated by the speaker's voice.

"I claim—

"A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movement of the diaphragm, substantially as described."

The following opinions, obtained from interviews with some of the leading authorities, will give a good idea of some of the questions which arise, and which will have to be decided by the courts.

Mr. Henry C. Townsend, of New York, who was formerly Examiner-in-Chief in the electrical department of the Patent Office, and who at that time put these cases into interference with a number of others, made the following remarks in the course of the interview:

The Edison patents for speaking telephone about which so much has been said in the public prints and which it has been claimed would give the Bell Telephone Company a practical extension of their monopoly under the Bell patent for the art of speaking telephone, appear in this week's *Patent Office Gazette*.

Those persons who look to these patents as the foundation for an extension of the Bell Telephone monopoly build their hopes on rather an insecure foundation.

The patents are all for details in one of the kinds of transmitters that might be used for varying an electric current by the action of the voice, and it is putting rather a low estimate on the inventive talent of the world to assume that none of the means heretofore proposed for varying the resistance of an electric circuit, and differing from what these patents disclose, may be made practical, or that no additional different means may be devised.

At various times since the inception of the art, means have come under my observation which, in my estimation, were fully capable of development into practical means for transmitting speech telephonically without employing the resistance of surface contact, and while many of such devices have not been introduced commercially, there is no reason in the nature of things why they should not be made commercially useful when the door is opened through the expiration of the original Bell patent.

One of the first questions, however, which will arise, in case these patents are litigated, will be whether or not the Commissioner of Patents did not exceed his authority in issuing them at all.

They are all for inventions which have been previously patented in foreign countries and the terms of some of the foreign patents have already expired.

Section 4,887 of the Patent Statutes provides that every patent granted for an invention which has been previously patented in a foreign country, shall be so limited as to expire at the same time with the foreign patent.

There would seem to be ground for the contention that there is no room for any term of patent in this country, the term of a previous foreign patent for the same invention having already expired.

It has been strenuously urged, however, in many cases in the Patent Office coming within my observation that wherever the previously granted foreign patent had run for its full term, so that it would not be existing as a foreign patent whose term was running, the section 4,887 could not have any application to the issuance of a patent granted subsequent to that expiration.

The corollary of that argument is that the United States patent should in such case issue for the full term of seventeen years.

I do not know for what terms these Edison patents have been issued, but if the argument is accepted in its entirety by the Courts, the patents will doubtless be held to be valid for the full term of 17 years.

I believe that no case is found published where the courts have decided upon just the same state of facts as exists in the case of these three patents, and as far as the United States Courts are concerned the question will be regarded as an open one.

It is pretty well settled, however, that had the United States patents been issued while the foreign patents now expired were running, they would have run only for the balance of the term of the shortest patent.

Mr. Franklin L. Pope, of New York, stated: The patents just granted to Mr. Edison appear to cover all forms of telephone transmitters in which carbon contacts are used, and, if sustained, as they possibly may be, they will give to the Bell Telephone Company an extension of the present monopoly so far as long distance transmission and all important exchange work is concerned. Various materials have been proposed to take the place of carbon, but none have proved, thus far, commercially satisfactory; carbon, in some of its forms, is the one substance which has been found to be adapted to all varieties of telephone transmitters. Hence patents which control the carbon transmitter control the major part of telephonic communication. Other forms of the telephone work satisfactorily for short distance transmission and small lines, and at the expiration of the present Bell patent will probably supersede to a greater or less extent that telephone for that class of work, but in all long distance transmission and the heavier exchange work in the large cities the form of instrument controlled by the various patents now in the hands of the Bell company will continue to hold sway, unless the patent is held void, or some inventor comes to the rescue with a transmitter without contact points.

Mr. Park Benjamin, of New York, gave the following opinion:

The three patents which were granted to Edison on May 3, 1892, were applied for, two on July 20, 1877, and one on April 27, 1877, so that they have been pending before the Patent Office for 15 years. It will probably be insisted that they are broad enough to cover practically any form of carbon telephone transmitter. On each one of these patents is noted the existence of prior foreign patents for the same invention, this being in accordance with the present Rule 46 of the Patent Office, which requires that the applicant "must distinctly state under oath whether the invention has or has not been patented to himself or to others with his knowledge and consent in any country, and if it has been, the country or countries in which it has been so patented, giving the date and number of each patent." This rule, as is well known, is made on the basis of Section 4,887 of the Revised Statutes, which provides that "Every patent granted for an invention which has been previously obtained in any foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time as the one having the shortest term of life." In view of Edison's affidavit no question can arise as to the identity of the invention described in these American patents with that devised and described in his prior foreign patents. The duration of an English patent is 14 years. All of Edison's English patents for these inventions were obtained on July 30, 1877, so that his protection in Great Britain expired July 30, 1891. The curious fact, therefore, presents itself of American patents first granted and yet voidable, if not wholly void, under the section of the Revised Statutes above quoted. Of course speculation will turn in the direction of why these patents were issued.

Without stopping to consider the question, or rather the quibble, which may be raised as to how a live patent can be limited to expire with a patent dead and non-existent at the time of the issue of the later patent; or to discuss the somewhat different question, the right of a commissioner of patents to grant a patent on its face void or voidable, it seems to me that it is not necessary to go far to find the reason for the issuing of these present patents to Edison. The applications which underlie them apparently were part of a series which he filed at about the same time, some of which became patents early in 1878, and others were delayed in the Patent Office. Of course it may be alleged that this delay was not that of the applicant, that it was due to interferences or other accidental occurrences over which he had no control; that if these patents had gone through the usual course he would have been in possession of them 14 years ago at least; and that now, seeing that he has been delayed through no fault of his own, and over so great a period that his foreign patent has had time to run its full course and lapse, it is a great injustice that for that reason he should be deprived of all protection in this country. Stress will probably be laid upon the fact that the invention is one to be found in every commercial transmitter in the world, that it is of the greatest public utility, that the Patent Office has admitted Mr. Edison to be the first and original inventor after 15 years' consideration of the fact, *and has now proved its faith by the issuance of these patents*, and, therefore, Congress ought to intervene and assist the slighted inventor and his inadequately rewarded assignee to a new term of the patents or a prolongation of the term which has expired, or give such other and further relief as in the opinion of the Bell counsel is justifiable and proper.

I think we shall hear of these patents before Congress long before we ever hear of them in court.

A prominent telephone man, in an interview, stated that he does not believe that the patents just granted to Mr. Edison will prove of any great value to the Bell Telephone Company, much less give them a continuation of the present monopoly; that the patents are merely modifications or improvements of existing patents, and not method patents, and consequently that the Bell company cannot claim either from these or the Berliner patent any exclusive right to the telephone. He did not see how two patents could be issued upon the same thing; that is, a second patent must be only upon details or improvements. The Bell Telephone Company has always made its plans with reference to the expiration of the present patent, and has

in many cases hesitated to make expenditures on that account, when it must have known the extent of the Edison and Berliner patents as fully as at the present time. There is every reason for that company to encourage reports to the effect that it has a continuation of the monopoly, since if it was known that such was not the case, its stock would rapidly depreciate. It is evident to every one that the granting of these patents has been purposely delayed through the influence of the Bell company.

Mr. Rudolph M. Hunter, of Philadelphia, who has had a very wide and varied experience with patents and patent office practice, states:

Patent 474,230 contains two things, neither of which would be infringed, in my opinion, by the transmitter in general use with our central stations. Of course, there are special instruments which might come within the terms of these claims. This patent would certainly not interfere with the use of the telephone by others.

Patent 474,231 appears to be broad, and, if it could be sustained under the broad interpretation, it might be sufficient to control the carbon transmitter. The scope, however, of the claim would be governed greatly by the file wrapper and the state of the art prior to the time that this broad claim was made in the prosecution of the application.

Patent 474,232 would not, in my opinion, cover the carbon transmitter in general use with our central stations.

The subject matter of all these three patents was patented in a large number of foreign countries in 1877, though in all cases the American application was filed first. Fourteen years from the date of the English patents would be 1891, consequently, under the decision of the Supreme Court in *Pohl vs. Anchor Brewing Co.*, 134 U. S. 381, these patents would be invalid. The last clause of this opinion reads as follows:

> In the view that section 4,887 is to be read as if it said that the United States patent is to be so limited as to expire at the same time with the expiration of the term of the foreign patent, or if there be more than one, at the same time with the expiration of the term of the one having the shortest term, the interpretation we have given to it is in harmony with the interpretation of the words "expiration of term" in analogous cases. *Oakley v. Schoonmaker*, 15 Wend., 226; *Beach v. Nixon*, 9 N. Y., 35; *Farnum v. Platt*, 8 Pick., 338. In those cases it was held that the words "expiration of term" do not mean expiration of term through forfeiture by breach of a condition, but mean expiration by lapse of time.

From this it would appear that, as the full term of fourteen years for the English patents had expired, the American patents to Edison were invalid when they were issued.

The Edison Lamp Patent Case.

The great incandescent lamp suit has been once more, and it is to be hoped for the last time, brought to a close. After more than a week's argument and the accumulation of hundreds of pages of briefs on either side, the case awaits only the decision of the judges. This is one of the largest patent suits ever brought into court, and the immense amount of capital involved gives it great interest, not only to those immediately concerned, but to all in any way connected with the development of incandescent lighting.

The patent under consideration was granted to Thomas A. Edison on Jan. 27, 1880, and was sufficiently broad, the complainant contended, to cover all practical forms of the incandescent lamp in use to-day. The case as tried before the Circuit Court last year was fully described in these columns at the time. It will be remembered that an injunction was granted the plaintiff, issued on July 23, 1891, which directed an accounting of profits and damages, but granted a stay pending appeal allowing the defendant to manufacture the lamps necessary to supply existing or future plants which used its apparatus, on condition of filing a bond to cover damages or profits.

The appeal, based on an assignment of errors in the judgment of the lower court, has been heard before the United States Circuit Court of Appeals, New York, Judges E. H. Lacombe and Nathaniel Shipman presiding. This is the first case of any importance that has come before that court. The attorneys for either side were the same as in the original case, viz.: For the Edison Electric Light Company, Eaton & Lewis, Clarence A. Seward, Grosvenor P. Lowrey, Albert H. Walker and Richard N. Dyer; for the United States Electric Lighting Company, Kerr & Curtis, S. A. Duncan, L. E. Curtis, E. Whetmore and F. H. Betts. Although a large part of the evidence is similar to that used in the lower court, yet many new points were brought up, and a brief review of the arguments in the present case cannot prove otherwise than interesting.

The defendants claimed in support of the assignment of errors that on Nov. 17, 1879, about two months before the date of the United States patent, a patent for the same invention was issued by the Canadian government, the term of which, as expressed on its face, was five years. March 5, 1880, a patent was also granted to Mr. Edison in Sweden, but this expired March 5, 1883, on account of its not having been put in practice in that country during the specified time in accordance with the condition affixed to the patent. The Canadian patent expired at the same time under the Canadian law to that effect. The United States revised statutes provide as follows: "But every patent granted for an invention patented in a foreign country shall be so limited as to expire at the same time with the one having the shortest term." . . . Accordingly, the United States patent expired with the Canadian on the 5th of March, 1883, or, if following the decision in the Pohl case, such was not the case, it must certainly have expired when the term expressed on the face of the Canadian patent came to an end, Nov. 17, 1884. As either date was prior to the filing of the bill in May, 1885, the court could have no jurisdiction, and should therefore dismiss the bill.

The original patent was granted for the term of seventeen years in spite of the fact that prior to its issue the invention had been patented in four countries, viz.: Canada, Nov. 17, 1879; Belgium, Nov. 29, 1879; Italy, Dec. 6, 1879, and France, Jan. 20, 1880. In November, 1883, the Edison company, through Mr. Edison, made application to the Commissioner of Patents for the correction of the patent, and included in the list not only the patents above named, but also a British patent dated Nov. 10, 1879. Thereupon on Dec. 18, 1883, the patent was "corrected" by the Commissioner, so that its term was limited to fourteen years from Nov. 10, 1879, which was the term of the British, the shortest of the foreign patents. The patent as corrected must be regarded as a new patent, granted upon application of Nov. 17, 1883, and it is well known that the invention had been in public use for more than two years prior to that date; accordingly the patent should be held invalid.

When the two old companies, "The Edison Electric Light Company" (the plaintiff in this suit) and "The Edison Company for Isolated Lighting" were consolidated on Dec. 13, 1886, to form the Edison Electric Light Company, the corporate existence of each of the consolidated companies ceased instanter. The new incorporation not only succeeds to the property, but to all the obligations and liabilities of the old companies, and hence it becomes the real party in interest in the pending suit. Even if it be held, however, that the plaintiff has the right to maintain this suit for the purpose of prosecuting it to final judgment, as far as damages are concerned, it has no right to an injunction.

By contract with Mr. Edison and the Edison Company for Isolated Lighting the plaintiff had conferred upon those parties such extensive rights and privileges that it had ceased to be the sole and exclusive owner of the patent in suit and had not such an interest in the same as to enable it to maintain the suit in its own name.

The fifth assignment of error relating to the interpretation of the patent and the infringement was made the one of chief importance. After a statement of the distinction between the arc and the incandescent lamp, the general nature of the latter and the laws of electricity involved in its use were thoroughly discussed. Then the broad field of "the prior state of the art" was entered. Beginning with the Geissler tubes and Crookes' radiometer every important form of apparatus connected with incandescent lighting was carefully considered in detail down to the lamps existing at the time of the issue of the patent in suit, including King's British patent of 1845, Roberts' British patent of 1882, Farmer's patent of 1879, Edison's platinum lamp, the patents of Woodward and Khotinsky, Lane-Fox, Scott, Pulvermacher and Van Choate, Carré, Gauduin and Sidot, Sawyer and Man and the lamps of Dr. Isaac Adams. From an examination of the foregoing patents it was evident that the following things were fully established in the knowledge of the art prior to Edison's invention, viz., the utility of carbon for the burner of an incandescent lamp, the utility of a high vacuum, the desirability of making the globe entirely of glass, the use of fine wires of platinum for leading-in wires, the arrangement of incandescent lamps in multiple arc to secure wide distribution, the necessity of giving the burner a high total resistance to secure such distribution, the making of the burner of small cross-section, the mode of reducing the raw material of the burner to shape before carbonization, and the use of a mixture of lampblack and tar or equivalent material in their manufacture. The only novel features in Edison's patent were the use of a carbonizable cement to attach the filament to the leading-in wires, the use of a carbon of high specific resistance, limiting the resistance to a minimum of 100 ohms and diminishing the radiating surface by coiling the burner. None of these features are infringed by the defendants' lamp. This is shown by a careful examination of the individual claims of the patent itself.

From the admission of Mr. Edison and the Edison company it was evident that they believed that Mr. Edison had made a generic invention sufficiently broad to cover all practical incandescent lamps with carbon burners, that his patent, No. 223,899, did not cover that invention, but was limited to a specific form of lamp, that such a patent could not be reissued, and that Mr. Edison was entitled to another and a broad patent. Such a patent they endeavored to secure. It is only on such a theory that the plaintiff's delay in bringing the present suit can be explained.

The decision of Mr. Justice Bradley in the McKeesport suit in reality supports the defendant, for the justice distinctly says "that the principal and great thing"—a burner of high resistance and small illuminating power placed in a high vacuum—was "well indicated and shown in Edison's earlier application for his platinum lamp." Among foreign decisions that of Justice Kay in England, and that of the Supreme Appellate Court of the German Empire, sustain the position now taken by the defendant.

It has been claimed by the plaintiff that this patented invention created a new art. So far is this from the facts of the case, that there is no evidence that a lamp constructed in accordance with the description of the patent was ever put to practical use. In fact, the development of electric lighting for the two years following the issue of the patent was very slow, and there is no reason to believe that its progress was in any way due to the invention of Edison.

In regard to the decision of Judge Wallace, upon the premises adopted by the court, logically its conclusion should have been that the invention was limited to the particular mode of analyzing a carbon burner, and that it did not involve patentable invention to seal up the carbon burner in a lamp globe, in a manner which is shown by the proofs and is admitted in the decision to have been old.

The sixth point made by the defense was the invalidity of the Edison patent. The patent could not be held valid for five reasons, viz.: It contains no definition of "carbonization;" the invention is not described in such terms as to enable a person skilled in the art to make a practical lamp; the patent fails to define "filament;" it fails to point out paper as the best material for burners known to the inventors and that it must be carbonized under strain and pressure; it describes no practical way of getting a durable working vacuum.

The last point in the defense was in regard to the inequities of an interlocutory injunction. The plaintiff's laches have been such that it has forfeited any right to an injunction which it may have had originally—certainly if defendant will come under proper guaranty to pay for the continued use of the patented invention whatever proper sum may be awarded by the court. In the present case the infringement was carried on openly for fully five years before the suit was brought. The plaintiff, having reason to believe that no attack would be made, had enlarged its operations from year to year until when the suit was brought it had nearly $2,000,000 invested in the manufacture of incandescent lighting apparatus and had erected over 1,000 electric lighting plants, with an aggregate capacity of 350,000 lamps and an estimated capital of $5,000,000. While the plaintiff would suffer merely nominal injury from the refusal of an injunction, the granting of one would be destructive to millions of capital. No injunction should have been awarded against the defendant in connection with the interlocutory decree. Therefore either the decree below should be reversed absolutely as to the injunction clause or such clause should be modified.

The argument in behalf of the Edison Electric Light Company was in substance as follows: After a brief analysis of the questions under discussion, a short outline of the art and history of the incandescent lamp was given, and the records of the more important former patents were examined in detail, somewhat as in the argument for the defendant, but with very different conclusions. From a consideration of these earlier patents two things were evident: First, that the problem of subdivision of the electric light had not been solved previous to the issue of the Edison patent; not only was this the case, but some of the most eminent authorities at that time declared that such a thing was a theoretical and practical impossibility, and when the first result of Mr. Edison's experiments in that direction were published they were discredited, and the whole idea ridiculed. But it is evident that Mr. Edison actually did solve this problem, and in a completely successful manner. Secondly, that carbon on account of its short life, when in a state of incandescence, had been regarded as unavailable for the construction of burners; in this case, too, Mr. Edison solved the difficulty and by the employment of a carbon filament was able to secure the results which others had totally failed to. Mr. Edison saw that the resistance of the lamp must be increased, but to increase the length of the burner was not sufficient for the surface was increased as well and the same amount of energy in a system of multiple arc would produce much less light when distributed among several lamps than if concentrated upon one; and he also saw that the proper result could be accomplished by reducing the diameter of the burner as well as the length, and thus secure the proper ratio between surface and resistance.

In regard to the first assignment of error, the Edison Swedish patent did not expire on March 5, 1883, but was simply forfeited on that day, and no forfeiture of any patent could, under Canadian laws, have any effect upon the Canadian patent. And even if the Canadian patent did expire with the Swedish patent, that termination did not affect the United States patent, because the termination of a foreign patent prior to its appointed end has no effect upon the corresponding United States patent.

As to the second assignment of error, the Commissioner of Patents had no jurisdiction to make any indorsement on the Edison U. S. patent relevant to any foreign patent, and, therefore, the correction of Dec. 18, 1883, was inoperative. Even if that correction were operative the limitation would not invalidate the patent; and even if it did invalidate the patent, no defense based upon that invalidity can be made collaterally in an infringement suit, but only directly in a bill to repeal the patent.

The defense has claimed that on account of existing contracts Mr. Edison and the Edison Company for Isolated Lighting, the plaintiff, had lost all rights in the present suit. This argument cannot hold, for, first, the plaintiff has never, by assignment or grant, alienated any portion of its patents; secondly, the Isolated Company has the right to manufacture and sell anything relating to electric lighting concurrent with the plaintiff, with the exception of the lamps; but the vendees of that company are obliged to take out a license from the plaintiff; third, the Isolated Company acquired no rights of any kind in the city of New York; fourth, Edison is the exclusive agent of the plaintiff to manufacture and sell lamps. In view of these facts, it is not possible to select any one of these various instruments as alienating a portion of the plaintiff's right in its patent.

The law on the subject of the fourth assignment of error is plain enough. It simply states that where two corporations are lawfully consolidated the new company, by virtue of the consolidation and without any other deed or transfer, acquires all the property of its constituent companies and all their rights of action, and that it may thereafter prosecute for its own benefit and in the name of either of its constituent corporations any suit pending at the time of the consolidation.

The fifth assignment of error urges that the second claim of the patent is invalid. The essential elements of the invention covered by this claim are: First, a carbon filament; second, a receiver made entirely of glass; third, a high vacuum in the receiver. The appellant will not venture to contend that an incandescent electric lamp having all these characteristics thus combined existed, or was anywhere described, before Edison contrived his lamp, and it is undeniably true that the lamp covered by that claim was literally new with Edison. After a careful examination into the electrical laws under which the incandescent lamp operates and a complete study of the application of these principles in the various forms of lamp which were patented previous to the issue of the patent in suit, as well as a search of the literature covering that period, the following conclusions are deduced: That there had been no anticipation of this combination either in the literature or in actual practice previous to that time; that Mr. Edison was without doubt the first to see that the cross section of the burner must be reduced in order to secure the necessary total resistance; that he was the first to devise a form of carbon which would be stable when heated to incandescence; and that he was the first to combine a carbon filament with a receiver made entirely of glass and exhausted to a high vacuum.

The defendant assigned as the sixth error that the court interpreted the second claim of the patent in suit so broadly as to include within its scope the lamp made by the defendant. From the examination of the patent itself and from other evidence it appears first, that the coiled form of filament is not essential to the invention. It appears that Mr. Edison had in mind when coiling the filament the prevention of the flickering of the light, and that such coiling would not be necessary if the driving engine were perfectly steady. Second, that high specific resistance is not necessary to the operation of the lamp, and its only function is contributing more efficiently to high total resistance. Third, in regard to a minimum total resistance of 100 ohms, a lower resistance is compatible with the invention, as is indicated in the model and drawing of the patent.

The seventh assignment of error differs from the fifth only in challenging the second claim of the patent for want of novelty in view of the state of the art, whereas the fifth challenges the second claim for want of invention in view of the state of the art. If the fifth claim is not held invalid, certainly the seventh, which implies a greater degree of identity with the prior art, cannot be so held.

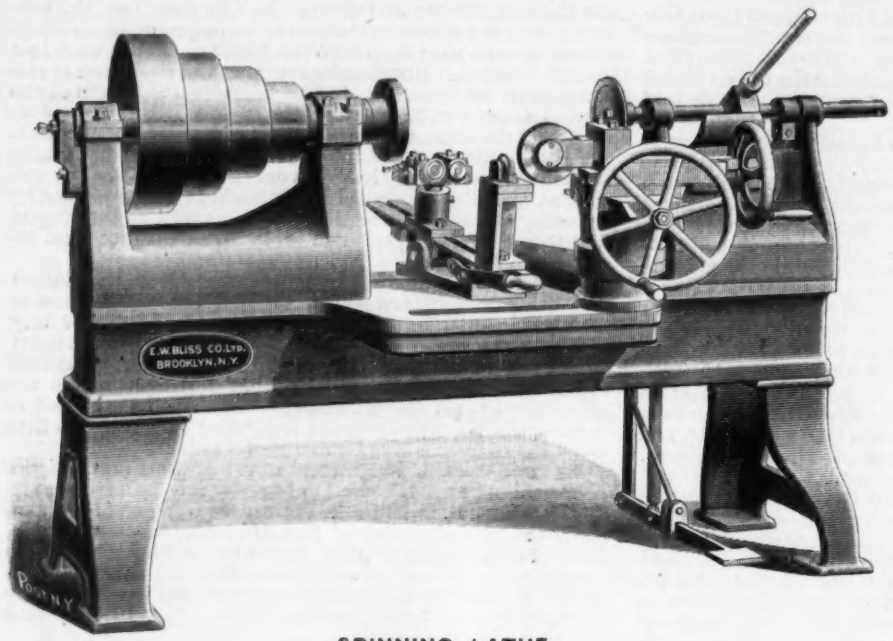
In reply to the eighth assignment of error that the patent was fatally defective by reason of several alleged deficiencies of description it may be stated that the evidence of Prof. Thomson from the standpoint of theory that successful lamps could not be made from the description contained in the patent, was not conclusive, and that the plaintiff, on the other hand, had by actual tests found that the said descriptions were entirely sufficient for the production of practical incandescent lamps.

The appellee's delay in bringing suit was excusable. Notice had been given to the appellant as early as 1882, and the owners of Edison's patent were seeking by suits in other countries to enforce its claims against infringers. And, further, that the law of laches is not applicable to a period of delay so short as five years.

New Design of Spinning Lathe.

The illustration shows a spinning lathe for sheet metal work, redesigned by the E. W. Bliss Co., of Brooklyn, N. Y. The change made has been in the direction of strengthening the parts, broadening and lengthening the wearing surfaces and increasing the size of the bearings.

These lathes are for spinning, burnishing, trimming and



SPINNING LATHE.

wiring such work as is produced by the drawing presses, where such spinning is necessary. They are also used for hand spinning from the flat, and when intended for that purpose a T rest is provided, instead of the compound rest.

They are built in the most substantial manner, with hammered steel spindles, bronze metal boxes and heavy compound slide rests, and are supplied either right or left handed as desired, and for either outside or inside spinning. Iron cones are supplied unless wood cones are specially ordered. The hardened steel burnishing roll is provided with anti-friction bearings.

By use of the tilting rest all but the largest articles can be spun, trimmed and wired at one setting. A countershaft with tight and loose pulleys and cone is provided with each lathe.

They are made in three sizes weighing 850, 1,200 and 3,000 pounds respectively.

Automatic Focusing Lamps.

The Thomson-Houston Electric Company has designed and manufactured the lamps shown in the

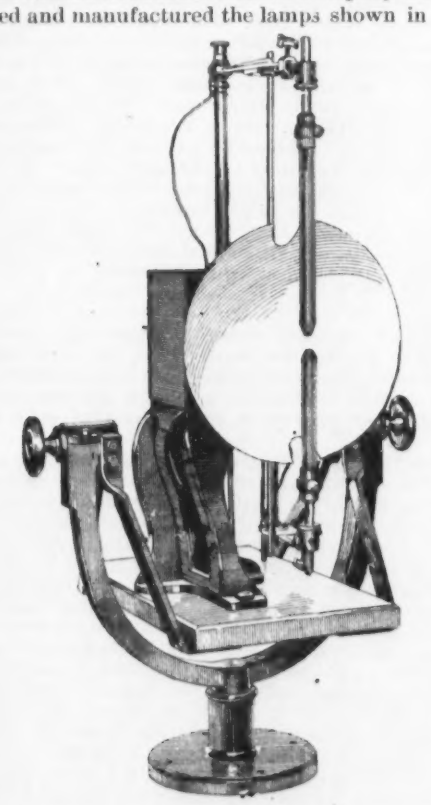


FIG. 1.—FOCUSING LAMP.

cuts to meet the requirements of the photographic art, and believes that they embrace all features found by long experience to be necessary. They are used in many places and have, in every instance, given uniform satisfaction it is stated.

The lamps are of two styles: Fig. 1, with vertical carbons, for all ordinary work, and Fig. 2, with carbons inclined so as to utilize all the rays of light possible direct from the crater. Fig. 1 is so arranged as to be capable of being turned through wide ranges both vertically and laterally. Fig. 2 can also be arranged in this manner when desired.

Both carbons in these lamps are automatically fed, thus keeping the arc always in the focus of lens on reflector. The feeding mechanism is operated directly by the current. The arrangement is such that the lamps can be attached to any tripod in the same way that a camera is mounted, thus avoiding the use of a separate stand. A white reflector is furnished for ordinary work.

By the use of these lamps photographers are independent of sunlight. Printing and other processes can be accomplished at night or on dark and cloudy days, thus saving much time formerly lost.

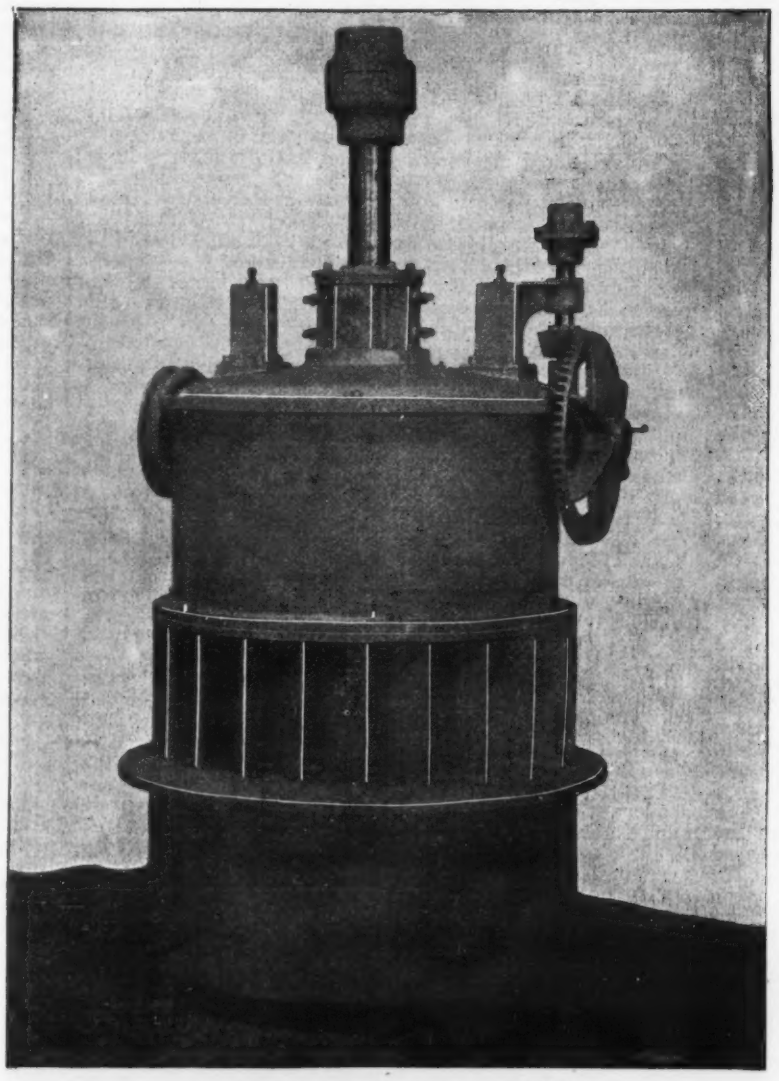
The light is steady and uniform in intensity, so that with a little experience exposures can be made with a certainty of obtaining the desired results. There are other uses to which these lamps are also applicable, such as theatrical effects, in giving stereopticon views, etc., and when desired they can be arranged for any special work.

Lamp No. 1 takes 30 ampères at 50 volts, and can, with a suitable rheostat, be used on any direct current circuit. Two lamps, with proper rheostat, can be run in series on a 110-volt circuit. A special lamp can also be furnished to run on arc circuits. Lamp No. 2 takes 20 ampères at 50 volts, and is to be used with a suitable rheostat on direct current incandescent circuits only.

A large number of lamps of this character are already in use for this class of work, and their popularity and the demand for them indicate that they are well adapted to the requirements.

Turbines for the Transmission of Power.

The electrical transmission of power over long distances is a demonstrated commercial success. This fact gives an immediate value to water powers, which have hitherto remained unimproved because located more or less remotely from transportation lines, or because the local demand for power was not sufficient to justify the expense. Our country

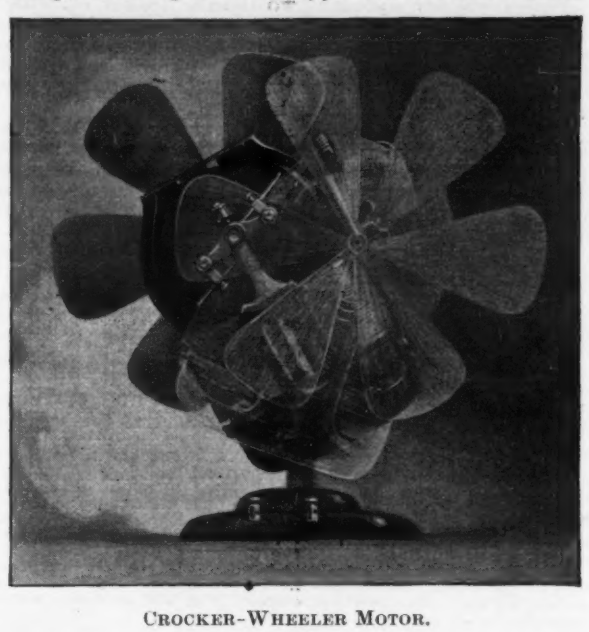


STILWELL & BIERCE TURBINE.

abounds in such water powers, some of immense magnitude, and it is only a question of time when all will be improved and the power generated, transported by wires to the surrounding cities and towns, and utilized for light, heat and power. In view of these facts a new and increased interest attaches to the question of turbines, their construction and application for the purpose of utilizing water power as referred to above. We show in the illustration a cylinder gate turbine which has been brought out by the Stilwell & Bierce Manufacturing Company, of Dayton, O. This company has met with a most gratifying success in the manufacture of these turbines, which have been designed to meet the demand and requirements of its patrons, and with a view of bringing out the highest efficiency as to power. These turbines are built in sizes ranging from six inches to 60 inches diameter, on vertical or horizontal shafts, in a great variety of plans adapted to all classes of establishments, from the simple country mill requiring 50 h. p. or less up to the mammoth cotton mills, paper mills or electric plants, consuming many thousand horse power.

A Pivoted Fan Motor.

In The Electrical World of April 2 an illustration and description were given of one type of the Crocker-Wheeler



Crocker-Wheeler Motor.

pivoted fan motor. The accompanying illustration, given on this page, shows another view of the motor as it is mounted upon an ornamental base. The motor is made to swing slowly around the circle upon a pivot, throwing a breeze in all directions. This fan motor is equipped with the Crocker-Wheeler variable speed switch, so that the force of the breeze may be regulated to suit the requirements. These outfits are furnished in one-twelfth horse power 115 volt motor, and with a one-sixth horse power motor fitted for either 115 or 230 or 500 volts, with self-oiling bearings. The one-sixth horse power 500-volt motor has only one speed.

Patent Exhibits at the World's Fair.

One of the most interesting and instructive exhibits at the World's Fair will be one illustrative of the growth of invention and the industrial arts by means of models.

"An outline history of invention in model form" is what, according to Mr. James Q. Rice, the special agent of the Patent Office, will be attempted. The models will be selected with reference to their

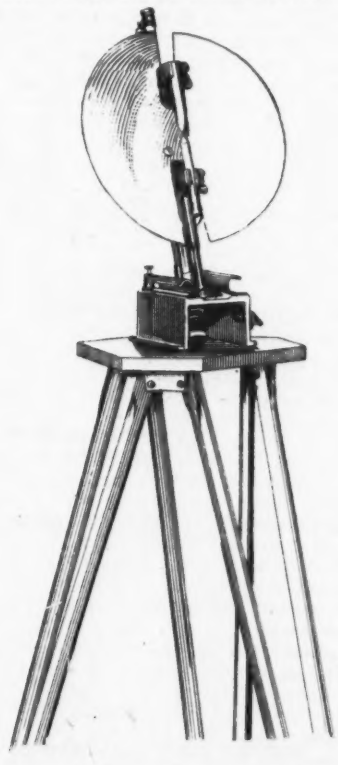


FIG. 2.—FOCUSING LAMP.

capacity for showing distinct advances in the principal arts, so far as possible, the aim being to start from the earliest beginnings of the arts and proceed step by step to the latest perfected machinery.

The task of doing this work would be comparatively easy, if the Patent Office possessed a complete set of models of the inventions patented in the last hundred years. But besides that few models have been required or filed since 1880, the fire of 1877 destroyed many of the older models, and some of the most important parts of the collection are missing. To fill the gaps for the purposes of the projected exhibit a Patent Office Committee, working under an appropriation of $7,500 from the Exposition, has a force of 15 men at work cleaning and burnishing old models, and making new ones when that can be done with little ex-

pense. Inventors and manufacturers all over the country are also being appealed to for assistance in the work. Promises from some of the large manufacturing companies of models of great value that have been carefully preserved for many years have already been received, and others have expressed a willingness to make such models as the committee may desire. The committee will be glad to receive suggestions from any one who may wish to communicate with them without a direct application on their part.

There will be from 3,000 to 4,000 models exhibited in the space (6,000 feet floor) assigned for the display. The representative of the department is Mr. H. A. Taylor; John M. Ewing is chief special agent, and the Patent Office Committee consists of James Q. Rice, special agent; J. B. Marvin, R. C. Gill, Malcolm Seaton and A. P. Greely. Correspondence should be addressed to Mr. James Q. Rice, United States Patent Office, Washington, D. C.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, May 7, 1892.

Review of the Market.—A single statement cannot fully tell the story of the stock market of this week, for the conditions have changed with almost every day and often during the day. The bulls and bears have each had their innings, and have in turn left their impress on the situation, but the influence of neither has been practically one-sided and not enough to permanently depress or raise prices. We note considerable fluctuation in some of the specialties, and on the whole the market is mostly a professional one. No material change in the money situation followed the opening of the month, as was rather expected, and that commodity is still more plentiful than the demand requires. Rates remain the same and there is not yet any promise of a change. Speculation continues to be confined within rather narrow limits and the market for bonds is better than for stocks.

The electrics have all had quite a boom, and quotations show a material advance over last week. They have attracted a major part of the attention of the brokers, and are booked for still further advances this month. Thomson-Houston and Edison have advanced together, one to 64 and the other to 106; and there is apparently good strength behind both of them. Westinghouse has about held its own, at top prices. Reports of a large World's Fair contract have served as an incentive to keep the buying interest active, and the public are inclined to look upon Westinghouse as a good purchase. It is reported that Fort Wayne will join the General Company's interests on the basis of 20. One share of the new stock will be given for five shares of the present Fort Wayne stock. Edison stock reached 106, upon sales aggregating about 9,000 shares for the week. Bell Telephone returned again to 207, and Western Union remains at top prices still. The Westinghouse Electric Company stocks have been taken from the unlisted department of the Boston Stock Exchange and placed upon the regular list. Th official sheet also shows that the Thomson-Houston Electric has been withdrawn and only the trust receipts officially recognized.

The General Electric Company, acting under the provisions of a recent act of the New York State Legislature, on Monday of this week paid into the State treasury $10,000 and filed its first certificate of incorporation. It also paid $15,000 as an organization tax on its increase of capital stock, referred to elsewhere in this issue.

West End Railway common stock has been sold at auction each day this week at the rate of 2,000 shares per day, at about 72⅛c. The par value is 50, so the company is realizing a handsome premium on these sales. The stock has been taken in large blocks by the best houses on the street and influential insiders. A summary of the sales to date shows:

Date.	No. shares.	Rate.	Amount.
May 2	2,000	$72.28	$144,568.75
" 3	2,000	72 47	144,937.50
" 4	2,000	72⅛	144,250.00
" 5	2,000	72⅛	144,250.00
" 6	2,000	72⅛	144,250.00
" 7	2,000	72⅛	144,256.00
Total 12,000 shares			$867,006.25
The same if sold at par			660,000.00
Premium realized			$267,006.25
Less commission to sellers, etc			19,500.00
Net premium to company			$247,506.25

The Erie Telephone Company has passed a very successful year. Its subscribers have increased by 870, and earnings have substantially increased; 4 per cent. dividends have been paid, and a surplus of more than one per cent. remains.

The Newton & Boston Railroad, referred to elsewhere in this issue, will raise the $150,000 necessary to complete its electric lines, by issuing stock on which to raise $100,000 and $50,000 by the sale of bonds.

The Metropolitan Telephone and Telegraph Company, through the Mercantile Trust Company, of New York, is calling in its bonds that were issued under the mortgage of May 24, 1888. July 1 is the date named for the purchase; and the price shall not exceed par and ten per cent. premium. Twenty thousand dollars is the total amount called in.

Edison Light and Power Company, of San Francisco. Coupons of the first mortgage 6 per cent, bonds of the company due May 3, 1892, will be paid by the New York Guaranty and Indemnity Company, 59 Cedar street.

The Boston Electric Light Company.—The official statement of the Boston Electric Light Company presented to the governing board of the Boston Stock Exchange, whose stock has been admitted to regular dealings by the exchange, as is stated elsewhere in this issue of THE ELECTRICAL WORLD, shows the following: The company was incorporated Feb. 14, 1888, under the laws of the State of Massachusetts. Authorized capital is $3,000,000. The capital as yet authorized by the stockholders is $1,500,000, of which $1,257,800 has been issued. Par value $100; non-assessable. The present list of officers is as follows: F. A. Gilbert, president and general manager; Hugh O'Brien, vice-president; Samuel S. Sias, treasurer, who, together with Isaac Fenno, William Butterfield, Dexter N. Richards, Moses Williams, E. B. Maltby and Henry S. Hyde are directors. The following is the financial statement, April 1, 1892:

Assets.

Plant and construction	$1,449,080.64
Real estate	378,337.88
Cash	37,540.87
Notes and accounts receivable	85,083.21
Supplies and material on hand	23,406.20
Horses and teams	1,157.39
Office furniture	1,569.83
	$1,976,176.02

Liabilities.

Capital stock issued	$1,257,800	
First mortgage bonds on account	300,000	
Notes and accounts payable	192,955 82	
		$1,750,755.82
Surplus April 1, 1892		$225,420 20

Auction Sale of Securities.—Among recent auction sales made by Richard V. Harnett, of this city, was $1,200 of bonds of the Accumulator Company, which sold for $8, $10 bought $600 worth, $5 bought $10,000 worth of them, $2.50 bought $5,000 worth, and $1 was paid for 200 $100 shares of the same company.

Stock Listed.—The governing committee of the Boston Stock Exchange has admitted to the regular list the Boston Electric Light Company.

To Issue Bonds.—The directors of the New England Telephone and Telegraph Company, at the annual meeting held in this city on Monday of this week, recommended the issue of a fourth series of $500,000 6 per cent. 15-year bonds during the coming year.

Annual Reports.—The Edison General Electric Company, in its annual report recently made to the Secretary of State, shows that $14,964,900 of the $15,000,000 capital authorized has been issued, $7,899,500 in cash and $7,065,300 for property used in the business. The debts do not exceed and the assets are equal to at least, $7,000,000. The annual report of the New England Telephone and Telegraph Company for the year 1891 shows gross earnings of $1,559,345, against $1,383,667 in 1890, an increase of $175,678. The expenses were $1,189,722 and the net earnings $369,622.45, a gain over the previous year of $30,992. The dividends took $338,630, against $298,265 in 1890, and the surplus for the year was $30,992 against $40,365 in 1890. The aggregate surplus is now $212,122. The total number of subscribers on Dec. 31, 1891, was 22,972, against 21,967 in 1890, a net gain of 1,028 exchange subscribers and a loss of 13 private line subscribers. The expenditure on the plant and equipment during the year was $908,897 against $765,353 for the previous year. The directors estimate the expenditures, maintenance and extension requirements for 1892 at $712,000. The following table gives a comparison for 1889, 1890 and 1891:

	1891.	1890.	1889.
Gross	$1,559,345	$1,383,668	$1,265,570
Expenses	1,189,723	1,045,038	957,305
Net	$369,622	$338,630	$298,265
Dividends	338,630	298,265	270,726
Surplus	$30,992	$40,365	$27,539

Dividends.—The People's Edison Illuminating and Power Company, of River Point, R. I., has declared a seven per cent. semi-annual dividend. The executive committee of the Erie Telephone Company has recommended to the directors that a quarterly dividend of one per cent. be declared, payable May 16 to stockholders of record May 7.

Increase in Capital Stock.—The General Electric Company on Monday of this week filed a certificate of increase in capital stock from $100,000 to $50,000,000. Of this $10,000,000 is preferred, entitling the holders to seven per cent. cumulative preferential dividends. The directors of the Chicago Edison Company at a recent annual meeting voted to increase the capital stock from $1,000,000 to $3,000,000.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, May 7, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
American Cable	...	.....	84	85
American Telegraph Co.	100	14,000,000	60	63
Western Union Telegraph Co.	100	86,200,000	92½	93¼
Commercial Cable Co.	100	7,716,000	155	160
Edison General Electric	100	15,000,000	107½	109
Edison Illuminating Co., of New York	100	4,500,000	79½	80
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
Edison Elec. Light Co. (of Europe) bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co.	...	500,000	20	40
East River Electric Light Co.	100	1,000,000	....	60
North American Phonograph Co.	...	6,600,000	5	8
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	3	6
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.	25	6,000,000	64	62½	63½	63¾
Thomson Houston Elec. preferred	25	4,000,000	29	....	29	29¼
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8⅞	9
Thomson-Houston Elec.—Series D	sh	120,000	7¼	....	7⅛	7¼
Thomson-Houston Int'n'al Elec	100	600,000	242	....	240	245
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	105
Thomson Elec. Weld	100	1,000,000	....	....	...	....
Thomson European Elec. Weld	100	1,500,000	10	....	10	12
Westinghouse Elec.—New Com.	..	6,000,000	29¾	28¾	28⅛	29
Westinghouse Elec.—Pfd.	..	4,000,000	47	45	45¾	46
" Trust receipts	..	10,000,000	....	....	....	....
Fort Wayne Elec	25	4,000,000	13¾	13¼	13⅜	13½
Fort Wayne Elec.—Ser. A.	sh	80,000	7⅛	....	7½	7⅝
Detroit Elec	10	1,000,000	7½	....	7½	7¾
West End St. Ry. Co.—Com	50	7,150,000	72⅛	72¼	72½	72¾
West End St. Ry. Co.—Pfd	50	6,400,000	86¾	86¼	86	86½
American Bell Tel	100	15,000,000*	207	202	207	209
Erie Tel. & Tel. Co.	..	4,800,000	47	46¼	46	47
Mexican Tel. Co.	10	1,280,000	....	....	1.00	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52⅛	52⅛	53
Tropical Tel. Co.	10	400,000	....	....	25c.	35c.

* Ex rights, 15, 15½.

NEW INCORPORATIONS.

The Harris-Woodruff Electrical Company, of Birmingham, Ala., capital stock $40,000, has been incorporated by W. C. Harris and W. L. Woodruff, both of Birmingham, to do a general electrical business, with authority to operate, buy or sell electrical railroads.

The American Electrical Company, of Portland, Me., capital stock $500,000, has been organized to build, equip, lease and dispose of electric light plants, etc. The incorporators are Fred. Balcom, of Philadelphia, Pa., and Geo. F. Gould and John Fagan, of Portland, Me.

The Centre and West End Passenger Railway Company, of Williamsport, Pa., capital stock $18,000, has been formed to operate an electric street railway in Williamsport. W. W. Champion, Wm. C. King and Jas. B. Ciryell, all of Williamsport, are the promoters.

The Cycle Clock Company, of Jersey City, N. J., capital stock $250,000, has been formed to manufacture, sell and let electric self winding clocks, etc. E. Erschell, of Long Island City, N. Y.; C. W. Meyer, of Brooklyn, N. Y., and E. Klahn, of Jersey City, are the promoters.

The American Battery Company, of Chicago, Ill., capital stock $1,000,000, has been formed to manufacture and sell electric batteries, dynamos, motors, electric carriages and other electric apparatus. The promoters are Geo. F. More, Chas. S. Kaufmann and Sam. E. Hibben.

The Jefferson Electrical Company, of Steubenville, O., capital stock $50,000, has been formed to generate and distribute electricity and build and operate a street railway. The organizers are Geo. A. Maxwell, Geo. P. Dravo, Wilson McKee, Geo. N. Henry and Wm. S. McCaulsen.

The Rockville Electric Light and Power Company, of Rockville and Indianapolis, Ind., capital stock $20,000, has been formed to erect and operate an electric light plant. Chas. E. Thornton, W. W. Hubbard and W. J. Hubbard, all of Indianapolis, are the promoters.

The Mountain Bank Coal Company, of New Whatcom, Wash., capital stock $300,000, has been formed to acquire, hold and dispose of electric light plants, etc. Jerry Neterer, C. L. Snell, S. A. Calvert, J. L. Heron, A. W. Dresser and J. M. Hitt, of New Whatcom, are the promoters.

The Cajon Mining and Water Company, of Los Angeles, Cal., capital stock $250,000, has been formed to mine, deal in water works and to furnish electricity for lighting, etc. The organizers are F. A. Marcher, I. E. Lucas, J. E. Lane, B. E. Toler and Wm. H. Toler, all of Los Angeles, Cal.

The Standard Electric Company, of Castle, Mont., with a capital stock of $100,000, has been formed to generate electricity for light, power, etc. Elmer J. Anderson, Hanson H. Barnes, John L. Fraser, Wm. A. Roots, Nahum T. Dinsmore and Chas. E. Miller, all of Castle, are the organizers.

AFFAIRS OF THE COMPANIES.

The Flint Electric Light Company, of Flint, Mich., at its annual meeting re elected all of its old officers.

Title Changed.—The title of the Citizens' Electric Light, Power and Heat Company, of Green Bay, Wis., has been changed to the Citizens' Electric Company.

The New England Telephone and Telegraph Company held its annual meeting in New York Monday, May 2, and re-elected its old board of directors, with the exception only that W. H. Elliot was chosen in the place of Benjamin C. Dean.

The Yonkers Schuyler Electric Light Company, of Yonkers, N. Y., on May 21 will apply by petition to the Supreme Court of New York at its special term for an order to authorize the company to change its name, and to assume the corporate name of "The Yonkers Electric Light and Power Company."

The Citizens' Electric Light Company, of Pontiac, Mich., has been organized, with George E. Fisher, president; Geo. H. Foster, vice-president; O. D. Chase, secretary and treasurer. The company has purchased the plant of the Detroit Electric Arc Light Company for $40,000, and will hereafter operate the same.

The Johnson Electric Service Company, of Milwaukee, at its annual meeting elected the following officers: William Plankinton, president; I. M. Bean, vice-president; W. S. Johnson, secretary and treasurer. These, with Jacob Friend and Francis Hinton, make up the directory. According to the report of the secretary and treasurer, W. S. Johnson, the year past has been a profitable one.

The Sandusky Electric Light Company, of Sandusky, O., has elected the following officers and directors: Directors, Geo. H. DeWitt, Watson Hubbard, R. B. Hubbard, H. C. Huntington, E. B. King, J. Kuebeler, C. H. Moss, C. G. Nieleson, G. W. Paine, H. C. Post, C. W. Sadler, Jos. Kronthal, Jno. Whitworth, James Woolworth, Thos. Wood, Jno. T. Mack, J. S. Cowdery. The board organized by the election of H. C. Post, president; E. B. King, vice-president; A. W. Prout, treasurer; Thos. Wood, secretary and superintendent.

The Railway Equipment Company, which was recently organized in Chicago by Mr. W. R. Mason, has purchased the capital stock, merchandise and entire business of the Electric Merchandise Company, and hereafter the business will be conducted under the name of the Railway Equipment Company. The Electric Merchandise Company is the company of which Mr. Mason was formerly general manager, and in acquiring its good will and stock the new company enters the field at once fully prepared to meet the demands of the trade.

Metropolitan Telephone Election.—The annual meeting of the stockholders of the Metropolitan Telephone and Telegraph Company was held Tuesday, May 3, in New York. John Van Horne was chosen chairman and John H. Cahill secretary. The annual report of the officers was presented and accepted. The following directors for the ensuing year were elected: Leonard F. Beckwith, Charles F. Cutler, Joseph P. Davis, Thomas T. Eckert, William H Forbes, George J. Gould, Dr. Norvin Green, Edward J. Hall, Jr., John E. Hudson, John Jameson, Charles A. Tinker, John Van Horne, William H. Wolverton.

The Langhorne Electric Light, Heat and Power Company, of Langhorne, Pa., at its annual meeting, elected the following officers: President, J. Howard Marshall; vice-president, P. M. Minster; treasurer, John Wildman; secretary, Alfred M. Wildman. The directors are P. M. Minster, J. H. Marshall, Thos. J. Duffield, John Rue, George L. Garsed, D. J. Matlack and A. R. Mitchell. The financial report was read by the secretary and accepted. The permanent investments amount to nearly $25,000 The receipts and expenditures of the past year were given, showing a surplus of about $650 in the treasury. The report was satisfactory to the stockholders present.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 9, 1892.

The Norwich Insulated Wire Company has removed its general offices from 58 Cedar street to 62 Green street, this city.

The Manhattan Electric Supply Company, whose offices are on Cortlandt street, this city, has removed its factory to 14 and 16 Morris street, Jersey City, N. J.

Mr. S. L. Barriett has bought out the Barriett Electric Company, and opened a shop at 161 Washington street, New York, where he is now manufacturing a full line of motors.

The Electric Engineering and Supply Company, of Syracuse, has removed its New York offices from 18 Cortlandt to 126 Liberty street, where Mr. F. C. Timpson will be glad to see all old friends.

Mr. C. E. Bibber, general manager of the Consolidated Electric Manufacturing Company, of Boston, Mass., was in New York this week en route to Chicago and the West. Mr. Bibber reports business as excellent with this company, and that the new Heyman lamp manufactured by them is being received with great favor.

The Government Time Ball.—It has been decided that the official time ball of the United States government will be dropped from the top of the Pulitzer Building in this city. The ball, which is to be four feet in diameter, will be dropped at precisely 12 o'clock by the government operator at Washington. The position selected is a very sightly one, and the highest of any point in the service.

Electric Lights for the Bancroft.—Commander John S. Newell, the inspector of electric lighting of the Navy Department, came to this city from Washington, Friday last, to make arrangements for the installation of the electric light system on the Naval Academy practice ship Bancroft. The Bancroft was launched at Elizabethport, N. J., on April 30 and will be ready for service in about three months.

The American Street Railway Track Company has been formed. E. S. Greeley, of The E. S. Greeley & Co., is president, and Samuel D. Nye, formerly of the Worcester Steel Works, will be general manager. The company will manufacture and sell the street railway material formerly manufactured by R. T. White, which includes the "Daisy" chair, girder rail and Eureka construction. Their offices will be in the Mills Building, this city.

The Echo Telephone Company, with general offices at 15 Cortlandt street, is now ready to negotiate with responsible parties for exclusive rights after March 7, 1893. The Echo telephone must not be confounded with acoustic instruments. It is a magneto telephone fully covered by patents which will come into effect as soon as the broad claim of Bell lapses. This claim as construed by the courts has stood in the way of many inventors and improvements, and the Echo telephone is destined to make itself heard throughout the United States after March 7, 1893. It is the embodiment of what many early investigators tried in vain to accomplish, viz.: a magneto-telephone operating effectively without the aid of battery, carbon contacts or induction coil, and transmits as well as receives the human voice by simple yet successful means.

The American Geographical Society of this city held a meeting on the evening of May 2 at Columbia College in the interest of the proposed survey of the north magnetic pole. The speakers were Prof. W. T. Trowbridge, of Columbia College; Prof. Meyer, of Stevens Institute; Gen. Greely, of the Signal Service, and Col. W. H. Gilder. The subject is one of general interest to the scientific world and the practical importance of such a survey has long been recognized. The neighborhood of King William's Land, off the northern cost off this continent, where the work is expected to be carried on, can be reached with comparative ease and little danger. A thorough study of all the magnetic phenomena observable in the neighborhood of the magnetic pole will be made, with special reference to whether the pole is moving and at what rate and in what direction. Many prominent men of science are interested in the matter. Col. W. H. Gilder, who with Lieut. Schwatka won fame in bringing back information as to the Franklin expedition, expects to go in charge and is confident of success.

Electrical Exhibition in November.—A special meeting of the department of electricity of the Brooklyn Institute was held last week to consider the question of an electrical exhibition to be given by the department this fall. James Hamblet was chairman and R. J. Murphy recorded. Prof. Franklin W. Hooper reported on behalf of the special committee appointed to select a place for the exhibition. It was originally intended to have held the exhibition in Clermont Avenue Rink this spring, but that plan was given up. Professor Hooper expressed himself in favor of the second or third week in November, to continue three or four weeks thereafter. He thought the exhibition should not be given up, but should be prosecuted because it would not only be of financial benefit to the section but also of great scientific advantage to the community. Several of the large electrical companies had promised their support and the exhibition would be something very elaborate, both in the amount of detail put in the show and also in the large effects which would be obtained. In response to the remarks of Professor Hooper a committee of two was appointed to confer with the Rink owners and to arrange the first convenient date after election in November for holding the exhibition. Several representatives of electric companies were present at the meeting and urged the plan with much fervor and seemed confident that manufacturers of all varieties of appliance would eagerly take floor space in the exhibition and would materially aid in the collection of apparatus of historical interest, if it was decided to make that a feature. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., May 7, 1892.

The New England Machine Company has been incorporated at Bennington with capital of $100,000.

The Haverhill Iron Works are to be closed out on May 14. It is understood that the industry has not been a paying one, though the works have been in operation a number of years.

Electric Lighting from the Trolley.—In Lowell, Mass., a number of lighting plants have been installed in which secondary batteries are stored directly from a trolley wire. An ingenious regulator automatically controls the rate of charge and discharge by cutting resistance in and out. It is stated that 56 cells are used. The batteries are manufactured by the Eastern Electric Light and Storage Battery Company.

Mr. A. M. Young, president of the New England Engineering Company, of Waterbury, Conn., has purchased a controlling interest in the Waterbury Horse Railroad. This company has no charter rights as yet which permit it to equip its lines with electrical apparatus, and will await the action of the Connecticut Legislature before steps are taken in this direction. Mr. Young, however, is a believer in the success of electric traction, and with his associates expects to give the citizens of Waterbury all the benefits that can be derived from a railway equipped with the best electrical apparatus that can be obtained.

The Boston Society of Operative Electricians held its regular semi-monthly meeting at the American House last Wednesday evening, President A. T. Chase presiding. The speaker of the evening was Mr. A. T. MacCoy, electrician of the United Telegram Company, who presented an elaborate and carefully prepared paper on the system used by that company for the distribution of stock quotations. The various instruments used and the arrangement of apparatus and circuits were carefully explained, being illustrated by some of the actual apparatus and by numerous diagrams. Mr. MacCoy's paper presented in a striking manner the completeness with which the details of this system have been elaborated, and formed a worthy addition to the numerous interesting and instructive papers with which the society has been favored during the past season. The society aims especially to bring before its members by lectures and discussions the practical applications of electrical science to regular commercial work of the society. All who might desire to become members are welcome to attend any all the meetings, which are held the first and third Wednesdays of each month at 8 P. M. at the American House. W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, May 7, 1892.

Friendly Appreciation.—The publication of Mr. Nikola Tesla's London lecture in THE ELECTRICAL WORLD'S issue of May 7 is generally most favorably commended. A gentleman in this city expressed his opinion of the same as follows: "The enterprise shown in giving us Tesla's London lecture in full and in advance of other papers is in keeping with THE ELECTRICAL WORLD'S journalistic enterprise and worthy of the highest recognition."

Hard Rubber Specialties.—Mr. M. C. Chase, 43 South Canal street, Chicago, is turning out a number of surgical specialties in hard rubber.

The Central Electric Company, Chicago, is sending out an attractive 24 page circular descriptive of standard sockets, switches, rosettes, etc.

Mr. H. I. Hadaway, one of George Cutter's commercial tourists, has just returned to Chicago from a successful Western trip, and reports bright business prospects.

Mr. W. H. McKinlock, president of the Central Electric Company, returned to Chicago this week from a trip to California with that prince of travelers, George Manson.

Mr. George H. Thayer, superintendent of telegraph of the Chicago & Northwestern Railway, is on a combined pleasure and business trip to the Pacific slope, passing the last week in Spokane Falls, Wash.

Mr. F. H. Prentiss, of New York City, the president of the Buckeye Electric Company, of Cleveland, O., passed several days in Chicago recently arranging matters of importance in connection with the World's Fair.

Mr. C. H. Rockwell, the genial treasurer and manager of the Buckeye Electric Company, of Cleveland, O., was in Chicago recently closing arrangements for the systematic handling of the Buckeye lamp in the West.

Clark & Marshall, manufacturers' agents, have moved from the Insurance Exchange Building to Room 413 the Rookery, Chicago, where they have an attractive exhibit of samples of the various specialties they are handling.

Mr. Robert Clark, of Peoria, Ill., has added a $6,000 stock of electric and combination fixtures to his already extensive line, and is thus prepared to supply the latest and best designs approved for modern residence or office use.

Mr. George Manson was in Chicago this week, en route to New York from a trip along the Pacific Coast, during which he inspected the marvelously compact and convenient telephone exchange that Mr. Sabin is completing in San Francisco.

The Great Western Electrical Supply Company, Chicago, has fitted up more extensive and convenient offices, and has also rearranged its show rooms, thus enabling it to display the varied lines of supplies and fixtures to better advantage.

Prof. Stratton, of the Electrical Engineering Department of the University of Illinois, Champaign, Ill., with his senior class in electrical engineering, visited Chicago recently and inspected all the principal electrical plants and isolated plants in the city.

The Electric Appliance Company, of Chicago, in speaking of Mr. Terry's new catalogue, said: "We hardly know which to admire most, the perfect and thorough manner in which every subject in this expensive work has been handled, or the kindly generosity exhibited in supplying us with early copies handsomely bound.

Mr. A. H. Bauer, chief electrician of the Pullman company, Chicago, will rewire the handsome Pullman building and increase the number of lights to 2,500. The building was originally wired when but little attention was paid to the quality of wire used in concealed work, but only the highest grade of insulation will now be used.

The Nutting Electric Manufacturing Company has moved its factory from West Jackson street to the newly remodeled six story brick building, 62, 64 and 66 South Canal street, near Madison, where ample facilities will be had for taking care of the large number of orders for the Nutting arc lamp for incandescent circuits.

Valuable Water Power.—P. F. Jacobs & Co., Chicago, offer for sale what is said to be the finest water power in the State of Illinois, and one considered admirably adapted to electrical development, more especially for parties desiring to utilize long distance transmission in supplying electric power to the manufacturing districts in the suburbs of Chicago.

Mr. George Mayo, of the Rockford Electric Manufacturing Company, Rockford, Ill., was in Chicago this week placing orders for the necessary supplies for an electric street railway that he will install at once in Independence, Ia., for Mr. C. W. Williams, the wealthy horseman. The road will be 3½ miles in length, and be completely equipped with Mayo motors and generators.

The Electric Spark.—Lovers of verse should not fail to secure a copy of the April number of this witty sheet and peruse the handsomely illustrated and charming poem written by Mr. William Taylor, the assistant manager of the Electrical Supply Company, Chicago, whose writings have ever been noted for that peculiar poetic quality that proves so successful in commercial life.

The Sunbeam Incandescent Lamp Company, Chicago, are sending out a circular letter calling the attention of users of incandescent lamps to the well known excellence of their lamp, especially in the point of brilliancy of light, in the giving of rated candle power absolute, and in long life, results they are enabled to secure by the use of a specially constructed filament of exceptional strength, which they claim will stand greater fluctuation in pressure and more over strain than carbons used in other lamps.

Mr. J. H. Cooke, well and favorably known to users of incandescent lamps throughout the country, who has been the active manager of the Sunbeam Incandescent Lamp Company for some two years past, severed his connection with that company on May 1, and assumed charge of the Chicago office of the Buckeye Electric Company. As a Western representative of the Buckeye Electric Company he will lose no time in presenting the merits of the Buckeye lamp to every user of lamps in his territory.

Mr. C. K. McFadden, chief of the electric light department of the Chicago & Northwestern Railway, has arranged an ingenious portable tripod for use in tracklaying or section work at night. Some of these tripods are now in use where the construction gang is relaying the track entering the new trainsheds, and support two Ward arc lamps placed in series with a resistance box, the necessary current being supplied from an Edison incandescent dynamo in the depot plant, the circuit wires being sufficiently long to enable the tripods to be moved from point to point as the work progresses.

Electric Light Contracts Let.—The South Park Commissioners have awarded the contract for an electric light plant at Washington Park to the Brush Electric Company, whose bid was the lowest of those presented. The Brush Electric Company, Standard Electric Company, Western Electric Company, Fort Wayne Electric Company, Abbott Brothers, and the Thomson-Houston Electric Company appeared as competitors, each offering a number of bids, which varied in amounts with the specifications as to cables and lamps—whether single, double, or triple. The Brush Electric Company agrees to erect and equip a plant fully adequate to the needs for $63,250.

Evolution of Telegraphy.—Space has been granted the Baltimore & Ohio Railroad Company in the electrical building World's Fair, for a display that will prove of great interest to all who have followed the progress made in telegraphy. Mr. J. G. Pangborn, who has charge of the exhibit, is endeavoring to secure the entire paraphernalia that was used in stretching the first telegraphic wire. It is not generally known that Prof. Morse attempted to lay the wire underground. He secured a heavy plow and rigged a reel upon it, from which was unwound a lead-coated wire. As the furrow was made the wire unwound itself and was soon buried from sight. An experiment was made and it was found that there was so much leakage that the underground system was abandoned. A few years ago the man who made the plow made a working model of the same. The skins of 16 oxen will be mounted to represent the original 16 that pulled the plow from Washington to Baltimore, and wax figures will represent Prof. Morse and his associates in the act of laying the wire.

The World's Fair Manufacturers' Exhibit, Engineering and Construction Company has been formed to supply experienced and competent men to take charge of all exhibits immediately on their arrival in Chicago; to unpack and if necessary erect, look after, sell or repack and reship same to exhibitor, who will thus have the satisfaction of knowing that everything will be done as he desires and with no fear of having his goods prejudiced by incompetent handling. This company will also make arrangements for space for those who have not already secured it. The officers of the company are: Mr. R. J. Randolph, for the past ten years engaged in the electrical business, having been connected with the Van Depoele and Excelsior Electric companies; Mr. C. A. Goslett, who is an Associate Member of the Institution of Engineers of London, England, has been a mechanical superintendent for the past fourteen years, and has erected some large central stations in this country for the Edison General Electric Company; and Mr. F. J. Howell, who has been connected with the Westinghouse and Edison General Electric companies for the past eight years. The headquarters of this company is located in Room 1325 Monadnock Building, Chicago. F. DE L.

News of the Week.

THE ELECTRIC LIGHT.

Pringhar, Ia., has voted in favor of electric lighting.

Cuthbert, Ga.—Bonds will be issued for an electric light plant.

Boonville, Ind.—A company has been formed and an electric light plant will be put in at once.

Brownsville, Tenn.—An effort is being made to secure an electric light plant for this place.

Lakeport, N. J.—The Concord & Montreal Railway Company will erect an electric light plant at this place.

St. Joseph, Mo.—Superintendent Yenawine, of the city electric light plant, asks for $18,000 for extension this year.

Hatboro, Pa.—The citizens of this place are examining into the cost of electric lighting with a view of introducing it into the town.

Bluffton, Ind.—The electric light plant formerly owned by Parker & Auer has been purchased by the city, and will be operated under municipal control.

The Vermont Electric Company, of Burlington, Vt., it is stated, is to utilize the water power at Winooski for the transmission of power and lighting.

Rock Hill, S. C.—The Rock Hill Electric Light Company has completed the change in its system from the incandescent to the arc system of street lighting. Westinghouse alternators are used.

Columbus, Ind.—The Commercial Club, composed of the merchants of Columbus, has organized a company with a capital of $20,000, and has been granted a franchise to erect and maintain an incandescent light plant.

Rockville, Ind.—The City Council has contracted with W. W. Hubbard, C. E. Thornton and J. J. Higgins, of Indianapolis, who are to erect an electric light plant in this place, for city lighting. The contract for the plant has been let to the Thomson-Houston Electric Company.

Reisterstown, Md.—The citizens of this town and Glyndon will hold a meeting to discuss the question of co-operating in the endeavor to secure an electric light plant for the two towns. Water will be used as the motive power, and it is thought that a plant can be erected for about $10,000.

Brooklyn Lighting Contracts.—The Brooklyn Aldermen decided on May 2 to make contracts with the Citizens' and Municipal Electric Light companies for street lights at the rate of $182.50 for a light for a year, and for incandescent lights at the following rates: Twenty-five candle power, 10 cents per night; 32 c. p. 12¾ cents per night; 50 c. p., 20 cents per night; 65 c. p., 23 cents per night; 75 c. p., 25 cents per night.

Nashville, Tenn.—The sale of the electric lighting plant of the Capital Electric Company to the Thomson-Houston Company, note of which appeared in THE ELECTRICAL WORLD April 23, has been confirmed by the court, and H. S. Manning, supervisor of construction for the purchasers, is on hand prepared to begin operations on the proposed extensions to the plant. Gilbert F. Brown, of Philadelphia, is in charge of the local affairs of the company.

The Laramie Electric Light and Fuel Company, of Laramie, Wyo., M. N. Grant, president and superintendent, has contracted with the St. Louis office of the Pond Engineering Company for the enlarging and remodeling of its steam plant. A new steel boiler of 125-h. p. capacity, with stack, rocking grates and improved furnace will be installed. The three old boilers of 70-h. p. capacity each will also be provided with rocking grates and improved boiler settings.

The electric light contract for the county buildings at the Kings County, N. Y., county farm at St. Johnland, which was let to the Thomson-Houston Electric Company by the Board of Supervisors, as stated in THE ELECTRICAL WORLD of April 30 has been vetoed by Supervisor-at-Large Kinkel on the ground that provision is made in the contract for buildings not yet erected on the county farm. Mr. Kinkel holds that the offer of the company to supply a

plant for the buildings already up at a cost of $97,000 should be accepted.

THE ELECTRIC RAILWAY.

New Orleans, La.—The contracts for the electrical equipment of the New Orleans & Carrollton Railroad have been awarded.

Danvers, Mass.—The Naumkeag Street Railway Company has been granted authority by popular vote to use electricity as a motive power.

Champaign, Ill.—The City Council has granted an ordinance to the Champaign and Urbana Electric Street Railway Company for an extension of its lines.

Electric traction will be substituted for steam upon the Third avenue line of the Brooklyn City Railroad Company from Twenty-fifth street to Fort Hamilton on Decoration Day.

The Newton & Boston Railroad has commenced the construction of an electric line from Newtonville through Newton Highlands to Newton Upper Falls. The cost of the road is estimated to be $150,000.

An electric railway connecting Urichsville and Dennison, Ohio, is to be commenced at once by McCormick & Moran, of Pittsburgh, Pa., to whom franchises have been granted by the Common Councils of both places.

Leavenworth, Kan.—The Leavenworth Rapid Transit Company's lines, which are controlled by the Kansas City, Wyandotte & North Western Railway Company, are to be equipped electrically and extensions made. The road heretofore has been operated by steam dummy.

Pittsburgh, Pa.—The Pleasant Valley Street Railway Company has purchased the Allegheny Street Railway, Allegheny & Bellevue Railway, Perry Street Railway and the Troy Hill Railway. An issue of $200,000 stock and bonds will be made to cover the new purchase and improve the roads.

Haverhill, Mass.—The Haverhill & Groveland Street Railway lines have been sold to the Industrial Improvement Company of Boston. The road has 15 miles of track and is to be equipped electrically and when completed there will be a through electric road 40 miles long from Lowell to the sea.

Jerseyville, Ill.—A plan for an electric enterprise is being considered, to include an electric road from Hardin, Calhoun County, to Jerseyville, via Fieldon and Otterville. The estimated cost is $80,000. The cost of a preliminary survey (about $300) is all that the citizens of the county are asked to contribute.

The Fitchburg and Leominster (Mass.) Electric Railway, now being constructed, is six miles in length. One and one-half miles will be equipped with Westinghouse motors and generators. Pierce Bros. are doing the construction work. Mr. G. E. Bowers is the electrical inspector of the equipment.

Yonkers, N. Y.—The Yonkers Street Railroad Company has changed its motive power to electricity, and three electric cars are now running on the Riverdale avenue route. The citizens are well pleased, it is stated, with the service of the new system. The other lines of the city will be equipped with electric cars by July 1.

The Steinway Railway Company, of Long Island City, N. Y., has been granted permission by the New York State Board of Railroad Commissioners to equip its lines electrically, subject to certain regulations laid down by the Board. The trolley system will be used and work will be begun at once, it is stated, on the proposed lines to Flushing and in Long Island City.

Memphis, Tenn.—A. M. Billings, of Chicago, proprietor of the Memphis street railway lines, has made a proposition to the City Council for the city to become a partner in street railway operations in Memphis. He has offered to issue bonds to the value of the street railway plant and franchises, approximating $1,250,000, which bonds he will take himself, and then issue stock for that amount and give the city half of it, his object being to avoid the constantly recurring conflict of interests with the city which may jeopardize his investment. The proposition is favorably regarded by members of the Council, it is stated, and may be accepted.

The Yonkers Electric Railroad, of Yonkers, N. Y., was opened for general traffic Monday, May 2, and cars have been running since that time continuously, giving universal satisfaction by their smooth and noiseless riding. The generating station is fitted out in the most approved style, containing two Edison 100-kilowatt generators, directly belted to high speed Ball engines. Gearless motors are used, of the Eickemeyer-Field system, which drive both car axles from the slow speed 20-h. p. motor by means of parallel rods, thereby avoiding all the wear and tear and the noise incident to high speed machinery. This road is of special interest still, in so far as the rails have not been replaced by heavier ones, but the old horsecar rails, which had done service for many years, have been left undisturbed and have only been bonded, because in this type of gearless motors the whole motor weight rests upon the car springs and thereby the destructive blow exerted upon the rails by the momentum of the motor is done away with.

PERSONALS.

Mr. Arthur L. Bosley, president and manager of the Pennsylvania Electric Engineering Company, of Philadelphia, has resigned. His address for the present will be Towson, Ind.

Mr. Robert Deeming, of the Stonington line of steamers, has been appointed president pro tem. until the annual meeting this month of the Scott Electrical Manufacturing Company, of New York, instead of the Schuyler Electric Company, as was stated in last week's issue of THE ELECTRICAL WORLD.

Mr. C. Everett Smith and Miss Emma E., daughter of Mr. and Mrs. J. L. Brownley, of Portsmouth, Va., were united in marriage recently in that city. Mr. Smith is well and favorably known throughout the country and holds the position of electrician in the navy yard. The wedding was the occasion of bringing together a large circle of friends of the young couple, who were the recipients of numerous and valuable wedding remembrances.

Mr. George Forbes, a well-known electrical engineer of London, England, is inspecting the Canadian side of the Niagara River relative to constructing a gigantic tunnel to produce electrical power for transmission to large manufacturing centres. He is accompanied by Edward T. Adams, president of the Cataract Construction Company; Edward A. Wickes, vice president, and William B. Rankine, secretary and treasurer of the same company, all of New York, who are interested in this new scheme and for which the Canadian government has granted a charter.

MISCELLANEOUS NOTES.

Praise from a High Source.—THE ELECTRICAL WORLD (Times building, New York) gives in its current number, May 7, the full text of Mr. Nikola's Tesla's London lecture, which will be found of intense interest to electricians. As an illustrated weekly review of current progress in electricity and its practical applications, the WORLD is clearly without a rival.—*Boston Traveller.*

The Milwaukee Board of Fire Underwriters has adopted a new set of rules governing the introduction of electric currents for lighting or power. The rules enter into details and cover both the incandescent and arc systems.

The electrical section of the Franklin Institute held its stated meeting on Tuesday, May 3. The following communications were presented: "Some Points Regarding Multiphase Currents," by Paul Winand, and "Ampère Centimetre: A Measure of Electro-Magnetism," by Carl Hering.

Electricity in Mining.—The Boston & Montana Mining Company has contracted with the Thomson-Houston Company for three generators for use in its electrolytic plant at Great Falls, Montana. It has been determined that the plant shall be patterned after the Lewissohn plant at Pawtucket, R. I., and work will be begun at once constructing the plant, which it is expected will be completed ready for operation by Nov. 1.

Industrial and Trade Notes.

The J. H. McEwen Manufacturing Company, of Ridgeway, Pa., has just installed two 100-h. p. engines for the Punxsutawney Electric Light Company, of Punxsutawney, Pa., which has lately increased the size of its plant.

The Lane & Bodley Company, of Cincinnati, O., has been awarded the contract for a complete power plant, including three 300-h. p. compound condensing engines, water tube boilers, heaters, pumps, condensers, shafting and clutches, for the New Orleans and Carrollton Railroad Company, of New Orleans, La.

The Weston Engine Company, of Painted Post, New York, has recently been sending out a very neat illustrated and descriptive catalogue of the Weston Automatic high-speed engine which this company manufactures, as well as high pressure boilers, besides contracting for complete power plants.

Another Case of Wet Steam.—Geo. P. Jones & Co., of St. Louis, manufacturers of machinery oils and greases, in a recent communication to THE ELECTRICAL WORLD state that "another large plant has tried our Peerless 'A' cylinder oil, and it stopped the groaning of the valves when all other kinds of cylinder oil had failed."

The Interior Wiring and Fixture Company, of 14 Clinton place, New York, electrical contractors and fixture manufacturers, makes a specialty of the conduit system of wiring and has at all times in stock a large and handsome assortment of gas and electric light fixtures of the latest and most attractive designs. A full exposition of the interior conduit system of wiring is also made at the company's show rooms.

The Berlin Iron Bridge Company has received the contract for the new rolling mill which the Waterbury Brass Company, of Waterbury, Conn., will build to replace the one lately destroyed by fire. It is said that this will be the finest rolling mill in the Naugatuck Valley, being 150 feet in width by 350 feet in length, with brick side walls and iron roof trusses covered with the Berlin Bridge Company's patent anti-condensation corrugated iron roof covering. The building will be absolutely fireproof.

The Interior Conduit and Insulation Company, of New York, has recently issued one of the most attractive and complete catalogues ever received in this office. It is profusely illustrated and gives a large amount of descriptive matter in regard to the specialties manufactured by the company, as well as a complete price list. The makeup of the book shows to nice advantage the interior and underground conduit specialties, also new and improved electric light, heat and power appliances. The typographical work is perfect.

Henry R. Worthington, 86 and 88 Liberty street, and 145 Broadway, New York, has recently issued a new catalogue of the well known Worthington pumps, pumping engines and hydraulic machinery. It contains ninety-six pages of very complete illustrations and descriptions of the apparatus manufactured by the firm, and its compact form and convenient arrangement commend it to the business man. In addition to the designs shown, many others are manufactured, some of which will be described in special catalogues now in preparation.

Electric Launches.—The specially built electric launch, constructed by Messrs. Woodhouse & Rawson United, Limited, at their Chiswick Works to the order of the Southport corporation, for use on their artificial lake, was running during the Easter holidays with remarkable success, it is stated. We are informed that this boat (the Bonnie Southport) will seat 40 persons, is 38 feet 5 inches, has 7 feet 6 inches beam, and draws about 2 feet 3 inches of water. She is carvel built, of bright mahogany, with a large counter, and is propelled by a 5-h. p. "W. & R." motor.

The Electric Appliance Company reports several very large orders for Swinging Ball lighting arresters, and also that it has recently furnished a complete equipment of these useful devices to a number of the largest plants in the western country. Station managers generally are beginning to realize that lightning arresters are as necessary as insurance on their plants, and from reports in regard to its efficiency it would seem that the Swinging Ball lightning arrester is filling the demand for an instrument that having once been put up can afterward be depended upon to remain in place and do its work without further attention.

No single piece of machinery in an electric light or power plant is more sensitive than the boiler feeder. It is, therefore, of high importance that the pumps used for this purpose be of the highest excellence. The Pond Engineering Company reports great success with their Blake pump for this service, recent shipments going to Albia (Ia.) Electric Light Company, Holden (Mo.) Electric Light Company, Warrenton (Mo.) Electric Light Company, Janesville (Wis.) Electric Street Railway Company, Camden (Ark.) Electric Light and Power Company, 2; Cicero and Proviso Street Railway, Chicago, and Vincennes (Ind.) Electric Light and Power Company, 2.

The Jersey City Smelting Works, E. A. Williams & Son, proprietors, 105-111 Plymouth street, Jersey City, N. J., is now prepared to furnish tested fuse wire of all kinds. Although fuse wire has steadily grown in favor for automatically opening the circuit, hitherto no systematic attempt has been made for standardizing it. This company is now preparing a carefully tested fuse wire, and has placed before its customers a correct system, and its circular contains tables giving the safe carrying capacity, the best lengths, the fusing points and weights of alls its wire. It also manufactures copper terminal fuses, plain fuse strips, wire and bar solder, tempered copper castings and commutator bars.

The Hall Signal Company.—The amount of business secured by the Hall Signal Company since Jan. 1 of this year exceeds anything heretofore accomplished in electric signaling and certainly reflects great credit on the management of the president, Mr. Wm. P. Hall. Since the beginning of the year three of the leading railroads of the country have adopted the Hall system of signals as standard and their orders thus far amount to more than a half million dollars. Mr. Hall's energetic efforts have been most ably seconded by his two active lieutenants, agents Young in the West and Brewster in the East. Estimates for large amounts are now being made for other roads, which will undoubtedly soon result in still further orders.

One of the most notable features of the World's Fair will be a complete model of the entire plant of the H. C. Frick Coke Company, of Scottdale, Pa. This company employs about forty million dollars capital in its business, and is the largest of the kind in the world. The contract has been let to the Jones Brothers Company, of 30 Court street, Cincinnati, O., who are experts in the making of models. The estimated cost of this model is between three and four thousand dollars. The plant will occupy a space about 20 × 50 feet, made on a scale of one twentieth of an inch to the foot, and will be an exact fac-simile of the original, including boilers, engines, piping, elevated tracks, cupolas, cars, and all other machinery, and will be in operation; the motive power, however, will be electricity.

The Jos. Dixon Crucible Company, of Jersey City, N. J., have issued a little circular on "The Use of Graphite in Electrical Work," briefly discussing the merits of their graphite manufactures from Dixon's graphite lead pencils to graphite crucibles and graphite paint. The graphite rods or carbons have the chief interest for electrical men, however. They are made of various diameters and lengths, ranging from one-fifth ohm to 500 ohms in resistance. Dixon's pure graphite rods of one-fifth to three ohms resistance have been used with great satisfaction on motors in place of the regular copper brushes. As graphite is not affected by acids, alkalies or any known solvent, and possesses high conductivity, it is believed that it will come into large use to produce a battery of high E. M. F. and small internal resistance.

The Detroit Electrical Works Gain a Point.—The Jacksonville Railway Company, of Jacksonville, Ill., W. S. Hook president, B. F. Sibert, superintendent, after carefully investigating the merits of the different street railway systems, on January 6, 1892, decided to divide their order for motor equipments between the Detroit Electrical Works and the Thomson-Houston company, and gave each an order for three 30-h. p. equipments, their object being to ascertain for themselves the comparative merits of the two systems for their benefit in placing future orders. The road was equipped and put into operation about March 1, 1892. May 2 the Detroit Electrical Works received an order for three additional 30-h. p. motor equipments. The equipments furnished by the Detroit Works under the original contract were their standard double reduction. Those furnished by the Thomson-Houston were their latest W. P.

The Ball and Wood Company, ever since the shipment of their first Improved Ball High Speed engine in October last, have been running 24 hours each day to keep up with their orders, and now have between 20 and 30 engines on the floor under construction all contracted for. Important additions to their works are under contemplation. Among their recent shipments are the following: Two 300-h. p. cross compound engines for the Brush Electric Company, Cleveland, O.; two 125-h. p. engines for the Yonkers Street Railway Company, Yonkers, N. Y.; one 300-h. p. cross compound engine for the Edison Electric Illuminating Company, Paterson, N. J.; three 150-h. p. standard engines for the Edison Electric Illuminating Company, Paterson, N. J.; one 100-h. p. engine for the Meriden Electric Light Company, Meriden, Conn.; one 150-h. p. engine for the Laconia Car Company, Laconia, N. H.; two 150-h. p. engines for the Chicago Arc Light and Power Company, Chicago, Ill.; one 100-h. p. engine for Sulzer Brothers, Winterthur, Switzerland; one 60-h. p. engine for the United States Navy Yard, Brooklyn, N. Y.

A Handsome Souvenir Pamphlet.—We have received from the Brush Electric Company a beautiful specimen of an illustrated pamphlet which is so far above the ordinary class of work of its kind that it deserves a more dignified name than that of catalogue. The souvenir is bound in illuminated covers, and includes descriptions of six complete incandescent electric light plants installed by the Brush company in six of the largest office buildings in the country, namely, the New York Life Insurance Company's buildings in Kansas City, Omaha, Minneapolis, St. Paul, Montreal and New York. The total number of lights furnished by these six plants is 11,400. The book is prefaced by a description of the Brush Company's direct incandescent system. The illustrations are the most artistic that we have ever seen in any electrical catalogue or descriptive pamphlet. Interior views are given of the various buildings, showing the distribution of the lights, the artistic chandeliers and the location and arrangement of the dynamo rooms. A fine illustration is also given of the United States cruiser "Boston," which is fitted with an incandescent plant of the Brush system.

The Dean Bros., of the great steam pump works, of Indianapolis, which bears their name, present perfect examples of the true American self-made men, says *Factory and Fireside* in a recent issue. There are five of the Messrs. Dean, and the loyalty of the brothers in sticking close to one another and to their business has brought them steadily to the front among the manufacturers in their line. When "Col. Tom" Dean came out of the army, at the close of the Rebellion, his younger brothers were struggling to fit themselves for the battle with the world. Besides the boys there were two sisters. One of these, Miss Mary Dean, has since then made a reputation with her pen, being a contributor to some of the leading magazines, and as bright a story writer as any we have. The Dean family lived at Willow Vale, a small place near Utica, N. Y. Their father, Judge Dean, after whom the village where the children were born was named, was a man of deep learning and high intelligence. The boys were ambitious to learn a trade, and they all entered the Rogers machine works. There they developed their muscle at the same time their inventive faculties expanded and it was not long before they had plans for improvements in the line of work into which they had entered. After perfecting their plans they "came West," locating in Indianapolis. There they began in a modest way to develop their own inventions, and were almost instantly successful. The rest is history in the manufacturing life of the Hoosier capital.

Large Power from a Small Amount of Water.—The Pelton Water Wheel Company have recently furnished the Commercial Mining Company, of Arizona, a power plant which affords a good illustration of the extraordinary results that can be obtained from a small quantity of water under a high head, as also the estimate of value placed upon water power where so large an outlay is made for a comparatively small amount of power. This plant consists of a four-foot Pelton wheel which runs under a 1,200-foot head at 699 revolutions a minute, developing 45 h. p., using a nozzle tip $\frac{13}{100}$ of an inch in diameter. Also a 24-inch Pelton wheel running under the same head at 1,380 revolutions, developing 20 h.p. with a nozzle tip $\frac{7}{100}$ of an inch diameter. These wheels run a concentrating and smelting plant, including rock breaker, blowers, pump, etc. The pipe line is 20,000 feet in length, the upper end being six and five-inch casing and the lower end five-inch lapweld pipe. All the water supply that can be counted on during the dry season is a flow of about 30 cubic feet per minute. The large expenditure here made in pipe line for results obtained will indicate the advantages of the utilization of water power even under much more unfavorable conditions than generally exist.

The Sioux City Engine Works have been running a full night and day force for the past two months, and have a large stock of engines on hand ready for prompt delivery. Orders have recently been received for one 22 × 48 Corliss engine for the United States Electric Light Company, of Dubuque, Ia.; one 34 × 48 for the Rhomberg Street Railway Line, of Dubuque, Ia.; one 36 × 42 to be used as a twin compound with an 18 × 42 in the Sioux City Electric Light and Power Company's Works; one 9 × 14 automatic for the Hotel Garretson, of Sioux City, and one 9 × 14 automatic for the Hotel Delone, of Omaha, Neb. They will soon ship to R. D. Hubbard, of Mankato, Minn., one 150-h. p. compound automatic engine. They are now erecting for the B. & M. Railway Company, at their new shops at Havelock, Neb., one 18 × 42 Corliss engine, and also one 100-h. p. compound automatic for the State University of Lincoln, Neb., and have recently started one of their 18 × 42 Corliss in the new factory of Sparr & Weiss, Milwaukee avenue, Chicago; also a 12 × 36 in the new factory of Ole Berg, West Side, Chicago; and one 14 × 36 Corliss for Blakeman & Dobson, Rockford, Ill. Their selling department has recently been extended. With selling agencies in Minneapolis, Chicago, St. Louis, Omaha, Kansas City, Dallas and Denver, the prospects for the largest output by far of any previous year are encouraging. They have recently bee adding some very large tools to their equipment, and are prepared to make figures on engines up to 1,000 h. p. capacity.

Business Notices.

The Consolidated Electric Storage Company's factory at Camden, N. J., was never kept so busy before as it is at present. It is making several types of battery, many of them new and specially adapted for every branch of the industry.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Molds for casting battery zincs are made of iron and steel. We have just completed sets for the "D'Infreville Patent Wasteless Zinc," costing over $40 each. H. Brooke, 44 Barclay street.

35-light, 2,000-c. p. American arc dynamo, in good condition, for sale at a bargain; also 750-light Westinghouse alternator, with station appliances. Address E. T. Pardee, 10 Butler Building, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MAY 3, 1892.

[Briefs prepared by W. A. Rosenbaum.]

473,911. Telephone-Exchange Apparatus; John J. Carty, New York. Application filed Nov. 25, 1889. A metallic circuit normally disconnected from ground at the subscriber's station thereon, a branch from said metallic circuit at the central office through a circuit-closing device, and a source of electricity to ground, in combination with a grounding key at the subscriber's station, whereby the circuit-closing device may be operated on grounding the metallic circuit at the subscriber's station.

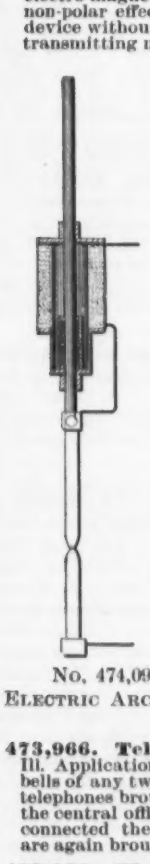
473,929. Solenoid and its Electrical Connections; Henry H. Hosford, Cleveland, O. Application filed June 3, 1891. In a solenoid, a series of energizing coils formed of a conductor closed from one coil to the other and having the outer extremities of said conductors closed on each other, thereby forming a closed or unbroken electrical circuit.

473,932. System of Electrical Conductors; Charles J. Kintner, New York. Application filed April 18, 1890. A system of electrical conductors, consisting of an insulated conducting main or lead connected at one end to one pole of a dynamo electric machine or equivalent source of electrical energy and located in an insulating conduit situated substantially above ground and provided with removable covers, in combination with a series of insulated branch conductors connected to the aforesaid main or lead, provided with concentric return conductors connected to the earth, the other pole of the dynamo being connected directly to earth and the conducting main or lead being removable from the conduit.

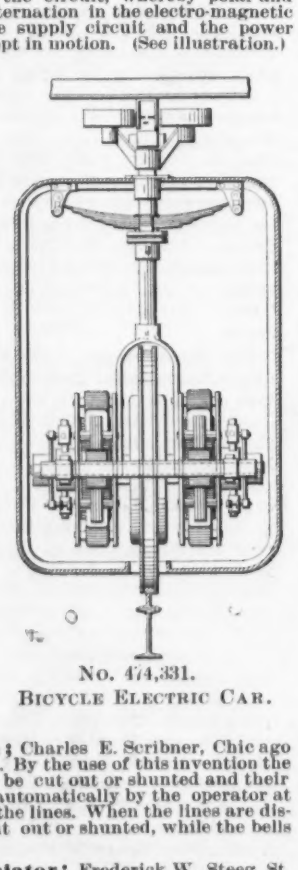
473,955. Electric Arc Lamp; Charles A. Pfluger, Chicago, Ill. Application filed July 16, 1890. An arc lamp provided with two separate and distinct gravity clutches, a main circuit magnet or solenoid always in circuit and working solely upon one of such clutches; a stop to throw such clutch out of operation when the arc has been established by its agency, and a derived circuit magnet or solenoid to actuate the other clutch and regulate the arc.

473,956. Electric Arc Lamp; Charles A. Pfluger, Chicago, Ill. Application filed Nov. 13, 1890. In an arc lamp, a current carrying device consisting of fingers to engage the carbon rod on opposite sides and means whereby they may be adjustably brought together, and a vertical pivot on which such device is supported, so that the fingers bear with equal pressure on opposite pieces of the carbon rod.

473,960. Electric Clock Motor; Anthony Reckenzaun, Stockwell, England. Application filed Dec. 16, 1889. In an electric clock or motor, the combination, with a power transmitting mechanism and an electro-magnetic device for maintaining movement of the mechanism from the supply circuit so long as there is a current in said circuit, of a pair of insulated wires in circuit with the supply circuit and wound side by side about said electro-magnetic device, and a make-and-break device in the circuit of one of said wires for automatically breaking the circuit of said wire without disconnecting the other wire from the supply circuit, said make-and-break device being operated on by the electro magnetic device to close the circuit, whereby polar and non-polar effects are set up in alternation in the electro-magnetic device without disconnecting the supply circuit and the power transmitting mechanism thus kept in motion. (See illustration.)



No. 474,091.
ELECTRIC ARC LAMP.



No. 474,331.
BICYCLE ELECTRIC CAR.

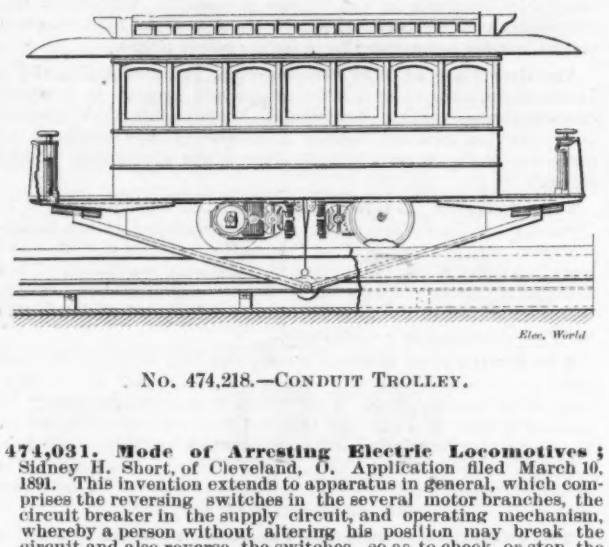
473,966. Telephone Switch; Charles E. Scribner, Chicago Ill. Application filed Aug. 19, 1884. By the use of this invention the bells of any two subscribers may be cut out or shunted and their telephones brought into circuit automatically by the operator at the central office as he connects the lines. When the lines are disconnected the telephones are cut out or shunted, while the bells are again brought into circuit.

473,975. Electrical Annunciator; Frederick W. Steeg, St. Paul, Minn. Application filed Oct. 24, 1891. In an annunciator, the combination of the indicator hand, two electro-magnets arranged in axial alignment, an endwise movable bar connected to the indicator hand, and forming the armatures to both electro-magnets and adapted to be moved thereby in opposite directions, two electric circuits in which said electro-magnets are respectively situated, and circuit closers for opening and closing said circuits.

474,001. Station-Indicator; James H. Dean, Minneapolis, Minn. Application filed Dec. 21, 1891. This invention consists in two parallel rolls, whereon the paper-sign strip is arranged and between which the signs are displayed as the paper strip is wound from one roll to the other, in combination with a small electric motor arranged between said rolls and geared to the same, a belt arranged upon said rolls, lugs thereon, an electro-magnet having an armature adapted to be tripped by the dogs upon the belts, a circuit extending through the electro-magnet and to the motor, a battery included in the circuit, and a circuit closer included therein and adapted to be operated by said electro-magnet, a branch circuit including the electro-magnet, and a circuit closer arranged in the said circuit and adapted to operate at street crossings or intersections to energize the electro-magnet, and thereby operate the first mentioned circuit closer to complete the circuit through the electric motor.

474,003. Electric Lamp Hanger; Elbert Dills, Sprague, Wash. Application filed Sept. 8, 1891. The invention consists of a spring-actuated drum located in a suitable casing and provided with certain details of construction.

474,008. Apparatus for Maintaining Constant Speed in Motor Mechanisms; John W. Gibbony, Lynn, Mass. Application filed Sept. 25, 1890. This invention is a novel method of and apparatus for controlling the speed of motor mechanisms, such as chronometers and other mechanisms; and it consists in providing such mechanisms with an electric retarding device and in varying the energy consumed in said retarding device or controlling its breaking effect in correspondence with the impelling or driving power required to operate the driven mechanism, whereby the speed of said mechanism is maintained constant and uniform, and whether the power tending to move the same be constant or variable.



Elec. World

NO. 474,218.—CONDUIT TROLLEY.

474,031. Mode of Arresting Electric Locomotives; Sidney H. Short, of Cleveland, O. Application filed March 10, 1891. This invention extends to apparatus in general, which comprises the reversing switches in the several motor branches, the circuit breaker in the supply circuit, and operating mechanism, whereby a person without altering his position may break the circuit and also reverse the switches, so as to check or stop the movement of a car by the operation of the motors in a local circuit.

474,037. Trolley Wire Circuit Breaker; Johan M. Anderson, Boston, Mass. Application filed Nov. 11, 1891. This consists of a non-conducting body, circuit terminals attached to the body near its ends, and an independent conductor attached to the non-conducting body and out of contact with the circuit terminals.

474,049. Insulating Support for Electric Railway Wires; Abraham A. Shobe and William Embley, of Jerseyville, Ill. Application filed Oct. 29, 1891. The object of this invention is to provide continuous or jointless conductors in which the several lengths of wire or rod of which they are composed are united end to end by being brazed, soldered or fused together, instead of being united by the ordinary lap or sliding joints adapted to yield to the longitudinal expansion and contraction of the metal of which they are made, thus forming continuous or jointless conductors, having uniform conducting capacity throughout their entire length.

474,050. Electric Switch; James J. Wood, Fort Wayne, Ind. Application filed Nov. 3, 1891. In a quick-action switch the combination of a switch lever in connection with a line circuit, two opposite forked terminal contact plates of rigid material, the bifurcations of which are entered by said lever in its movement, and a spring plate carried by the lever and arranged to enter with it, the bifurcations of which are entered by said lever in its movement, and a spring plate carried by the lever and arranged to enter with it the bifurcations of the contacts and to press outwardly against one side thereof while forcing the lever in contact with the opposite side of it.

474,067. House Telephone System; Charles E. Scribner, Chicago, Ill. Application filed Nov. 22, 1889. The combination, with three or more users' telephone stations, of metallic circuit telephone lines, one for each station, extending to all the stations and provided each with a connecting device at each station, and a user's outfit at each station, consisting of a loop-plug and cord, a telephone switch, a telephone and bell, and a battery with both poles extended to each of said stations and normally open, and a key included in one strand of each of the cords at each station, whereby the user at any given station may readily signal any other station to bring the two stations into telephonic connection over a metallic circuit.

474,073. Electric Resistance Box; Aloys Wirsching, New York. Application filed March 18, 1891. In a rheostat or resistance box, the combination, with two suitably spaced frames having the inner or opposing face of one of them provided with guideways, of spacing blocks made of insulating material and fitting in the guideways and between the frames, and a wire wound in spiral layers with the spacing blocks interposed between the layers for supporting and ventilating the wire.

474,091. Electric Arc Lamp; William B. Luce, Brookline, Mass. Application filed Aug. 8, 1891. This invention has for its object to provide an electric arc lamp in which a single magnet serves the double purpose of a lifting magnet and a feed magnet, and this purpose is accomplished by means of a solenoid provided with a magnetic core, having a clutch secured to or forming part of it. (See illustration.)

474,166. System of Electrical Distribution; William H. Elkins, Cambridge, Mass. Application filed July 11, 1891. This invention relates to dividing the current from a dynamo in such a way that two separate circuits will each be supplied with a constant current, even if the resistance in either circuit be varied without regard to the resistance in the other circuit; and it consists in a dynamo within a dynamo with a plurality of circuit, each independent, except that the armature coils, which at any moment make part of one circuit, are carried by the revolution of the armature into such relation with the brushes of each circuit that each armature coil makes a part of each circuit once during every revolution of the armature, that is to say, each circuit is externally independent, each has its own brushes, and the positive and negative brushes of each circuit are energized by those coils of the armature between them at any moment, but a coil which forms part of one circuit at one point in the revolution of the armature will form part of the other circuit at another point in the revolution of the armature.

474,140. Thermostat; Alfred B. Morse, Easton, Mass. Application filed April 28, 1891. In accordance with this invention a safety contact is placed outside or beyond the regular normal contacts between which the contact arm normally moves, the said contact arm when moved beyond the normal contacts cooperating with the safety contact to reverse or oppose the action of the adjacent normal contact.

474,149. Thermostat; Lewis G. Rowland, Camden, N. J. Application filed Oct. 7, 1891. This invention consists of a non-conducting support with movable and stationary contact plates and means consisting of a head, a tube secured to said head by a fusible solder, and a plunger or rod for preventing the movable plate from contacting with the stationary plate until a temperature is had causing the solder connecting said plate and tube to fuse.

474,165. Regulator for Dynamos and Motors; William H. Elkins, Boston, Mass. Application filed Feb. 6, 1890. The invention relates to controlling the difference of potential between the terminals, and consists in a novel arrangement of three brushes on a side, so connected to the terminals that the electromotive force of each terminal may correspond with the electromotive force of either one of the three brushes on a side or by means of a variable resistance between two brushes on the same side of the commutator may be graduated at any electromotive force desired between those of the two brushes then in contact with the commutator.

474,214. Telephone Receiver; Arthur Thomas Collier, Caterham Valley, England. Application filed June 30, 1891. An important feature of my said invention is the construction of the telephone with two diaphragms or tympans, each of which is placed between two magnet poles or between two magnet coils, and with an earpiece or mouthpiece, which is connected with the air chambers or spaces between the diaphragms or tympans and the adjacent ends of the inner magnet or magnets.

474,218. Conduit Trolley; James J. Cosgrove, Jr., of Philadelphia, Pa. Application filed June 3, 1891. The combination, with an underground line wire and a car carrying electric motors, of downwardly converging arms having sliding connections with the under side of the car, a trolley mounted in the converging ends of the said arms, connections with the underside of the car, a trolley mounted in the converging ends of the arms, connections between the trolley and the motors, and means for raising and lowering the trolley. (See illustration.)

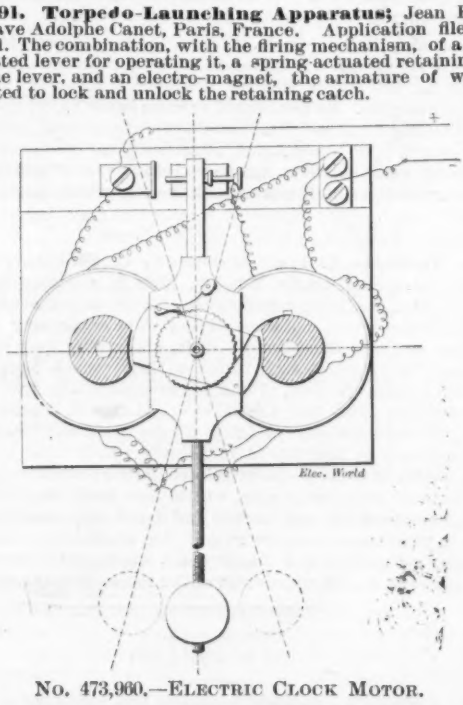
47 ,230. Speaking Telegraph; Thomas A. Edison, Menlo Park, N. J. Application filed April 27, 1877. For description see page 338.

474,231. Speaking Telegraph; Thomas A. Edison, Menlo Park, N. J. Application filed July 20, 1877. For description see page 338.

474,232. Speaking Telegraph; Thomas A. Edison, Menlo Park, N. J. Application filed July 20, 1877. For description see page 338.

474,266. Electric Arc-Lamp; Alfred Lyster Shepard, London, England. Application filed Aug. 6, 1891. In a system of electric lighting mains arranged for running arc lamps in parallel branches of two in series, the combination of two arc lamps arranged in series between the mains, one of the lamps having the regulation of its arc controlled by a coil in series with its arc and the other lamp having its regulation mechanism controlled by a coil in shunt upon its own arc.

474,291. Torpedo-Launching Apparatus; Jean Baptiste Gustave Adolphe Canet, Paris, France. Application filed June 9, 1891. The combination, with the firing mechanism, of a spring-actuated lever for operating it, a spring-actuated retaining catch for the lever, and an electro-magnet, the armature of which is adapted to lock and unlock the retaining catch.



Elec. World

NO. 473,960.—ELECTRIC CLOCK MOTOR.

474,319. Insulator; Charles F. Goodrich, Chicago, Ill. Application filed Dec. 29, 1891. An insulator for electric wires, comprising a body portion of insulating material and two staples or loops having their ends embedded within said insulating body and their looped portions extending to the outside of the said body.

474,323. Telephone-Circuit; Hammond V. Hayes, Cambridge, Mass. Application filed Jan. 13, 1892. This invention comprises a mode of operation and an arrangement of circuits whereby two circuits united at a station, to which both converge, may independently and reciprocally employ for their transmitters one and the same source of current located at such central point, and also an organization wherein such mode and arrangement are made applicable to the common use of the same generator simultaneously by more than one such pair of telephone circuits.

474,328. Electric Motor Mechanism; Sam. E. Mower, New Haven, Conn. Application filed May 21, 1891. The combination, with an axle, of an electric motor to rotate it independent of the axle, a sprocket-wheel on the axle, a sprocket-chain, a sleeve on the armature shaft of the motor, a sprocket-wheel on said sleeve, a gear on said sleeve, and reducing gearing between said gear on the sleeve and the armature shaft.

474,331. Bicycle Electric Car; Eben Moody Boynton, West Newbury, Mass. Application filed April 20, 1891. The main object of this invention is to so suspend the car from the motor that it is entirely independent of the same, permitting the latter to perform the slight undulations inseparable from running on any kind of road without compelling the car to partake in the same. A further advantage claimed is the possibility for each driving-wheel to place its axis normal to the rail, no matter if running on a tangent or on a curve, thus permitting an easy running on the latter without any unnecessary friction between the wheel and rail, and also without danger of the wheels f climbing the same. (See illustration.)

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1868—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.